

H
410-20-02
1953
c.1

Bulletin No. 41 (2nd Revision)

March, 1953



Care and Feeding of Dairy Cattle

BY

DEPARTMENT OF ANIMAL SCIENCE



FACULTY OF AGRICULTURE
UNIVERSITY OF ALBERTA

Edmonton, Alberta, Canada

UNIVERSITY OF ALBERTA
FACULTY OF AGRICULTURE

Care and Feeding of Dairy Cattle

BY

DEPARTMENT OF ANIMAL SCIENCE



Distributed by
Department of Extension, University of Alberta
Edmonton, Alberta, Canada

COMMITTEE ON AGRICULTURAL EXTENSION AND PUBLICATIONS

Andrew Stewart, B.S.A., M.A., LL.D., D.Econ., President of the University, Chairman.

A. G. McCalla, B.Sc., M.Sc., Ph.D., F.R.S.C., Dean of the Faculty of Agriculture, Vice-Chairman.

Donald Cameron, B.Sc., M.Sc., Director of Extension.

L. W. McElroy, B.Sc., M.Sc., Ph.D., Professor of Animal Science.

J. D. Newton, B.S.A., Ph.D., Professor of Soils.

B. T. Stephanson, B.E., Associate Professor of Agricultural Engineering.

E. H. Strickland, M.Sc., F.E.S.A., F.R.S.C., Professor of Entomology.

H. R. Thornton, B.Sc., Ph.D., Professor of Dairying.

John Unrau, B.S.A., M.Sc., Ph.D., Professor of Plant Science.

S. O. Hillerud, B.S.A., Department of Extension, Secretary.

TABLE OF CONTENTS

	Page
Introduction	5
Requisites for profitable dairying	6
The ideal dairy cow	7
Breeds of dairy cattle	8
Selection of dairy cattle	16
Breeding problems	18
Artificial insemination	20
Feeding	22
Composition of feeds	22
Function of feeds	24
Yearly feed requirements	25
Nutritional value of feeds	26
Concentrate mixtures	28
Thumb rules for feeding	29
Feeds for dairy cattle:	
Roughages	31
Leguminous hays	31
Alfalfa	
Sweet Clover	
Red Clover	
Alsike Clover	
Perennial grass hays	32
Timothy	
Slender Wheat Grass	
Brome Grass	
Crested Wheat Grass	
Red Top	
Upland Prairie	
Reed Canary Grass	
Annual Grass hays	34
Oat	
Barley	
Straw	34
Roots and Tubers	35
Silages	35
Oat	
Sunflower	
Legume and Grass	
Concentrates	36
Cereal grains	37
Oats	
Barley	
Wheat	
Rye	
By-products	38
Beet pulp	
Wet Brewers' grains	
Flaxseed	
Linseed meal	
Meat Meal	
Molasses	
Wheat Bran	
Wheat Screenings	
Wheat Middlings or Shorts	
Commercial Protein and Mineral Supplements	40

TABLE OF CONTENT—Continued

	Page
Minerals	41
Salt	
Iodine	
Calcium	
Phosphorus	
Commercial Mineral Mixtures	
Vitamins	43
Water requirements	44
Summer feeding:	
Value of pastures	45
Grain feeding on pasture	46
Pasture crops:	
Perennial grass	46
Legume	47
Alfalfa	
Sweet Clover	
Red Clover	
Pasture Mixtures	48
Supplementary pasture crops	48
Feeding and care at calving time	49
Raising the calf	51
Milk substitutes and calf meals	55
Dehorning	57
Care and feeding of the bull	57
Cost of producing milk	59
Milk secretion	62
Cow testing	65
Barn requirements	67
Diseases and Treatments	73
Brucellosis (Bang's disease)	73
Mastitis (garget)	76
Milk Fever	78
Pneumonia	78
Indigestion	79
Bloat	80
Winter Dysentery	81
Foot Rot	81
Sterility	82
Calf Scours—White Scours	83
Calf Pneumonia	84
Ringworm	85
Tuberculosis	85
Gestation table	87

Care and Feeding of Dairy Cattle

BY

J. E. BOWSTEAD

Dairying in Alberta began with the early settlers and has grown in importance as the population has increased. Experience has shown that conditions in certain areas of Alberta are suitable for dairying. There has been a steady increase in dairy production to the extent that for many years there has been a surplus of dairy products in the province, largely in the form of creamery butter.

Prior to World War II the annual value of dairy production in Alberta was \$17,000,000 to \$18,000,000. By 1952 the value of dairy products had risen to over \$56,000,000. Of this amount the dairymen of the province received over \$30,000,000 for the dairy products sold and approximately \$15,000,000 represents the value of dairy products consumed on the farm either by the families or by farm animals as skimmilk, buttermilk, whey or whole milk. The balance of \$11,000,000 represents the costs of processing and marketing dairy products by the commercial dairy industries in the province.

The large increase in the income from dairying since the pre-war years is largely due to increases in the prices of dairy products, since the actual increase in milk production has been less than 2 percent.

There has been a decrease of over 30% in the number of milch cows since the years preceding the war. This decline in the dairy cow population has been more than offset by an increase of 40% in the production per cow. It is estimated that in 1952 the average dairy cow produced approximately 5,800 lb. of milk containing 203 lb. of butterfat. These figures may indicate that there has been a general trend toward specialized dairy farming and away from the practice of milking scrub cows that are unable to produce sufficient milk for profit.

The increase in production per cow has been accompanied by an improvement in breeding, feeding and management practices. Many dairymen have come to realize that a dairy cow has to be well bred, intelligently fed and properly housed and cared for to produce sufficient milk and butterfat to yield a profit. Still greater increases in production and dairy profit can be secured by continued improvement in breeding and feeding practices.

There are many districts in the province where dairying should not be depended upon for the chief source of income.

These areas are more suited to mixed farming practices, in which a small herd can be profitably maintained. There are still many areas suited to a mixed type of farming in which dairying may occupy an important place when combined with the raising of hogs, poultry or cash crops.

In the event that dairying is to continue as an important industry, it is suggested that improved methods must be adopted in order to increase the net return and at the same time to meet the competition of other farm enterprises and also to survive through periods of relatively low milk and butterfat prices. Guidance is also needed in properly establishing dairy herds in areas suited to mixed farming. This bulletin has been published for the purpose of giving practical advice to those already engaged in dairying and to farmers who may be considering establishing dairy herds.

REQUISITES FOR PROFITABLE DAIRYING

Dairying is regarded as an intensive farm enterprise because relatively more capital and labor are required to produce a dollar's worth of product than in the case of most other farm enterprises. Dairying also necessitates a particular knowledge of practices involved in the breeding, feeding, maintaining the health of the herd, and care of the raw product, hence it follows that only farmers with these qualifications and an adaptability and liking for this type of farm production are likely to make a success of the business.

The Dairy Cow Must be Well Bred.

Only cows capable of producing enough milk to yield a reasonable income over costs of production can be considered profitable dairy animals. The ability to produce milk in large quantities is inherited, and therefore profitable cows are the result of good breeding and careful selection. The heavy producing dairy cow must be of a type which has been developed for the production of milk. She must have a strong frame, big barrel and large mammary development, since these characteristics are directly related to her ability to produce milk.

The Dairy Cow Must be Well Fed.

Dairying will only prove profitable when the cows are intelligently fed. Since all milk produced is indirectly derived from the feed, the feeding of cows becomes of paramount importance in successful dairying. The rations must contain all the ingredients of milk and in the right proportion for maximum production and greatest economy. The dairyman must know the feed requirements of cows, the composition of feeds, the feeds most suitable

for milk production and their cost, if he is to feed his cows most efficiently and secure maximum production from them.

Labor Must be Efficiently Utilized.

Dairying is not a seasonal enterprise. It is a yearly business in which work has to be done every day. The numerous chores that are necessary in dairying must be wisely, efficiently and regularly performed because carelessness and neglect in the proper care of the dairy cow reduces milk production.

Profitable Dairying Requires Both Brains and Brawn.

The combination of good breeding, intelligent feeding, and proper management constitutes the basis for profitable dairying. Any improvement made in the breeding, feeding or care of the herd will increase production as well as profit.

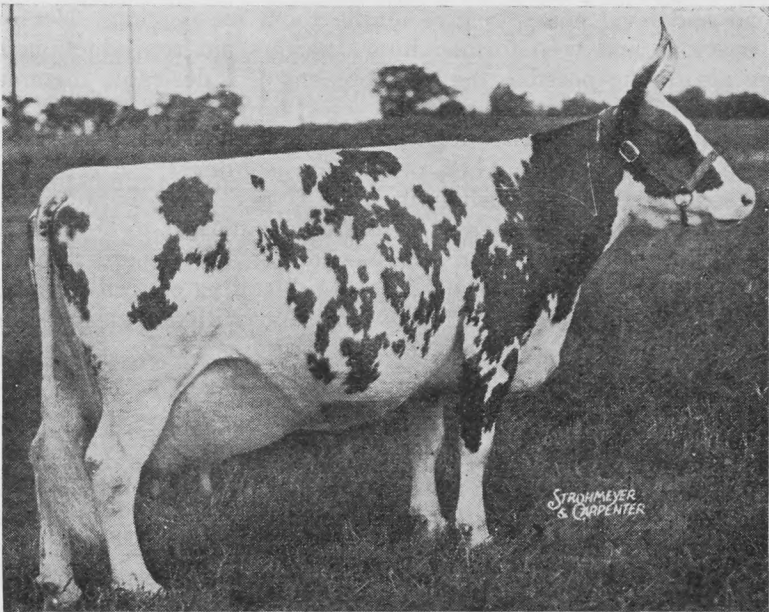


Fig. 1—The highest scoring Ayrshire cow for type and outstanding producer.
Barr Old Style, Imp.

THE IDEAL DAIRY COW

The ideal dairy cow is one which conforms to the type that makes the production of large quantities of milk physically possible. The type of cow and the ability to produce milk are related. When we breed for production, we also breed to get the type of animal

associated with high milk production. The superiority of the pure breeds of dairy cattle over scrub or most grade cattle is the result of over a century of constructive breeding and selection for both type and production. A knowledge of what constitutes the ideal type is essential for the intelligent selection of both males and females if a profitable dairy herd is to be secured.

General Requirements.

An ideal dairy cow must be able to consume and digest large quantities of feed, convert them into milk, reproduce regularly and maintain health and vigor over a long period of years. To be physically able to do these things effectively, the cow must have (1) a large udder of good quality, long, wide and strongly attached with teats of fair size, properly placed, and milk veins that are prominent and tortuous, (2) a large barrel, which indicates a large feed capacity; the back carrying this barrel must be strong and straight, and the ribs long and well arched, and (3) a long, broad and level rump to give ample room for calving. Not only do spacious and well formed hind quarters aid reproduction, but they also make possible the development of a desirable mammary system. (4) A large heart girth gives ample room for the heart and lungs, so they will function normally to keep the cow in good health and to lengthen her period of usefulness. (5) Freedom from excess fleshiness when in milk is necessary because there should be a natural tendency for the food nutrients to be manufactured into milk rather than into beef or fat. (6) There should be beauty and style which result from the blending of well developed body parts into a symmetrical whole, and with an alertness and carriage which is pleasing to the eye.

BREEDS OF DAIRY CATTLE

Purebreeds are Superior.

Improvement of dairy cattle dates back many centuries. The dairy herds have been developed as a result of careful selection and breeding for increased production, and for a type associated with production. Such planned selection and breeding have continued to be practiced within each breed until at the present time each of the pure breeds of dairy cattle is superior to non-purebred cattle for both type and production.

The Choice of a Breed.

The choice of a breed should be based upon the special qualities possessed by each of the different breeds, upon their suitability for conditions under which they will be raised, as well as upon the available markets for particular dairy products and breeding stock.

All of the major dairy breeds are being successfully raised in the dairy districts of Alberta, and no one breed has proven to be superior to all others. There has been a tendency in the past for the breeds producing high test milk to predominate in creamery districts, whereas breeds producing milk of lower test predominate in cheese factory districts and on dairy farms near large urban centres. If, however, a dairyman in a creamery area wishes to raise large numbers of swine or poultry that can utilize large quantities of skimmed milk, cows producing the lower test milk may prove more profitable under his conditions.

Select a Breed Popular in Community.

There are advantages for all dairymen in one community to raise the same breed of dairy cattle, or in districts where the dairy cows are not purebred to use purebred bulls of the same breed. Such a condition facilitates the purchase and sale of breeding stock within the community. In areas where there are many dairy herds of the same breed, it is possible to develop a popular strain of purebred cattle for sale outside the community.

A knowledge of breed characteristics is essential in making a selection of a breed. Each breed has its strong points as well as weaknesses. In making any selection, care must be exercised in obtaining animals that possess both good type and breeding, so as to avoid inherent weaknesses often found even among purebreds. The following information should aid in breed selection.

The Holstein-Friesian Breed

Holsteins in Canada have for many years outnumbered all the other dairy breeds combined, and in Alberta rank high in popularity. They are one of the oldest breeds of dairy cattle, having been developed for centuries in the Rhine delta of Europe by the early tribes that settled in that area.

Holsteins are the largest of the dairy breeds, mature cows weighing from 1,300 to 1,600 lb., and mature bulls from 2,000 lb. up. They have strong, large frames and barrels, which give them the ability to consume large quantities of hay and pasture. Although Holsteins increase rapidly in size and weight, they reach sexual maturity comparatively slowly. They are usually bred to calve at from 27 to 30 months of age. Cattle of this breed have strong, rugged constitutions and are hardy and healthy. While Holsteins have adapted themselves to a wide range of conditions, they do best where feed is plentiful.

Based upon production records of thousands of purebred animals, Holsteins produce more milk than those of any other breed, and although their milk may have the lowest average test, the

production of butterfat is not surpassed. The highest butterfat production record for a Holstein cow in Canada is that of Alcartra Gerben. She produced 27,745 lb. of milk and 1,409.0 lb. of butterfat in 365 days. More than 75 Canadian Holsteins have produced over 1,000 lb. of fat and more than 30 cows have produced over 30,000 lb. of milk in a year.

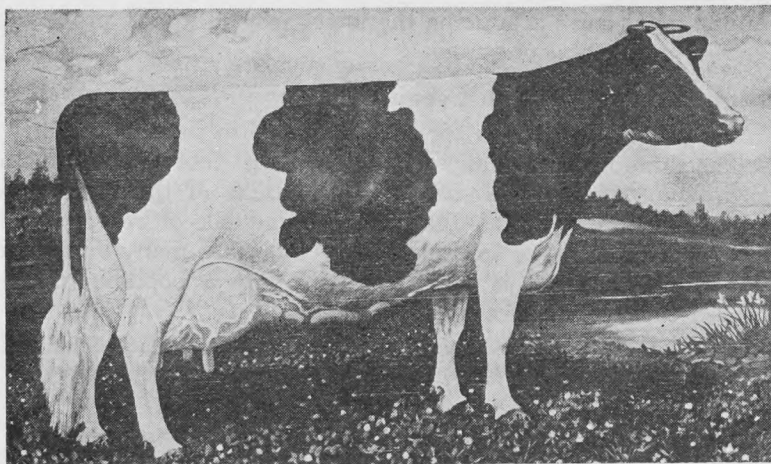


Fig. 2—True type, Holstein-Friesian cow.

The color is black and white. Most purebred breeders prefer cows that are approximately 50% black and 50% white. Holstein cattle are moderately upstanding, with strong frames, spacious middles and good constitutions, which enable them to withstand cold and rigorous conditions. This fact does not imply that such conditions can be imposed without seriously affecting their milk producing ability.

Holsteins are noted for the extent of mammary development. While the udders are usually large, they are often not as well shaped nor as well attached to the body as is desirable. In former years many Holsteins were criticized for having pendulous udders and large teats of poor shape. The rumps of some animals were inclined to be short or sloping and this was partly responsible for the undesirable shape of some udders. During the past 25 years, purebred Holsteins have been considerably improved in general appearance and dairy form, and the common faults of the mammary organs and rump are being corrected.

Holsteins are docile and even tempered, but at the same time show alertness and vigor which is desired in all dairy cattle. This breed can be successfully raised in all parts of Alberta where pasture and hay are plentiful, and where ample grain is fed to produce large amounts of milk. They are especially desired on farms where large quantities of skimmilk can be used for hog and poultry feeding, and also around large urban centres and cheese factories where whole milk is required.

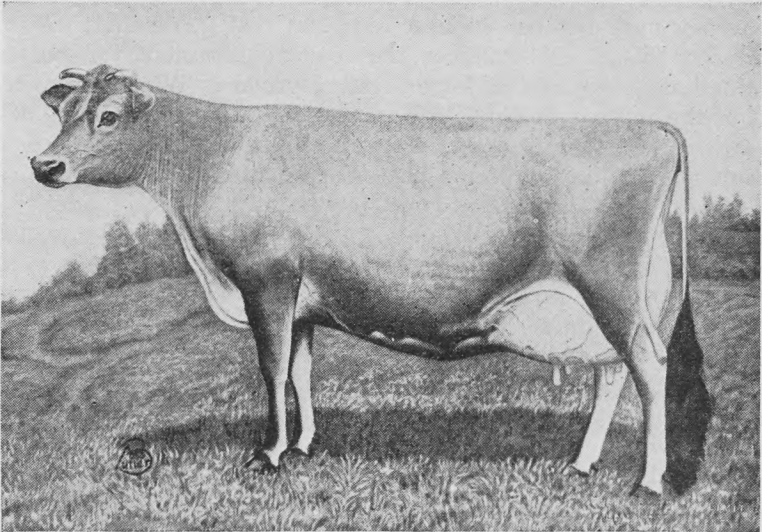


Fig. 3—Standard type Jersey cow, approved by the Canadian Jersey Cattle Club.

The Jersey Breed

The Jersey breed of cattle is especially popular in creamery districts where butterfat production rather than milk is the major objective. Large numbers of Jerseys are also raised near the larger urban centres where there is a demand for milk with a high test. Jerseys have proven themselves to be adapted to most conditions prevailing in the better dairy districts of the province.

The homeland of the Jersey breed is the island of Jersey where centuries ago the people improved the dairy qualities of their native island cattle. In order to preserve these desirable qualities, the Government passed a law in 1763 which prohibited the importation of any live cattle to the island. Since that time the improvement has continued, and animals are being exported to all parts of the civilized world.

The breed is the smallest of the major dairy breeds. Mature cows weigh between 900 and 1,100 lb., and bulls from 1,300 to 1,600 pounds. They are the most refined of all the dairy breeds, being relatively fine in bone and possessing those qualities considered ideal for dairy type. Considering their small size, Jerseys have large barrels, enabling them to make use of rations containing a large proportion of roughage. They mature rapidly and can be bred to calve at 24 to 26 months of age, or even earlier if well developed. Jerseys are also noted for their longevity, and many cows produce calves regularly to a relatively old age.

Jersey milk has the highest butterfat test. The high test milk produced by Jerseys reduces the feed requirement for butterfat production below that of lower testing breeds. While the average test of the milk is around 5.4%, many of the better animals of the breed average over 6%. As a result of the high test, Jersey cows are able to produce as much butterfat as those of any other breed. The world's butterfat record for Jerseys is 1,313 lb., made by the Canadian cow, Brampton Basilia.

Jersey cattle range in fawn color from light gray, cream, yellow, red, even to dark brown. The lighter colors are the most popular. Solid colored animals are preferred to those with white spotting, although in recent years animals with white markings have been increasing in number. Bulls are usually darker in color. The muzzle is always black, but the tongue and switch may be either black or white.

The body type of the Jersey conforms very closely to the ideal for a dairy cow. Jerseys show pronounced dairy temperament as indicated by their freedom from excess flesh, quality of skin, and refinement of bone. The excess refinement of some animals may lead to weaknesses of body frame and lack of constitution, ruggedness and apparent thrift. The lack of size and extreme leanness of the Jersey make them of little value for beef or veal. The udder shape and body attachment is usually very good. Jerseys have a very active disposition and are very alert. Nevertheless they are very docile and are recognized as the family cow. When improperly managed there is a tendency for some bulls of this breed to become unruly or vicious.

Jerseys are noted for their adaptability to most conditions. They are well adapted to humid and hot climates, but are not considered hardy enough to withstand exposure to extremely cold weather. While they may suffer more from the extreme cold of Alberta winters than certain other breeds, it is fair to say that such exposure is often the result of poor management. Jerseys have thrived on Alberta farms whenever they have been well housed and cared for.

The Ayrshire Breed

Ayrshire cattle have become better established in eastern Canada than in the western provinces. In Alberta the Ayrshire breed has gained a foothold in quite a number of districts and has contributed substantially to the dairy industry of the province.

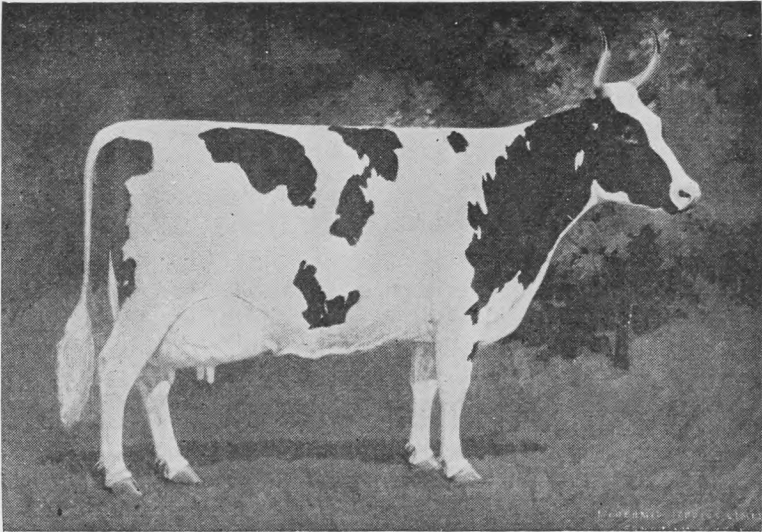


Fig. 4.— Model Ayrshire cow.

The Ayrshire breed had its origin in the county of Ayr in Scotland, where the climate was rigorous and feed none too plentiful. With the adoption of better agricultural methods, crop production increased and the livestock could be better fed and cared for. The farmers developed a special interest in their cattle, as is indicated by the fact that numerous livestock shows were held throughout the county. Breed type was emphasized during the period of improvement, and this fact accounts for the uniformity of type of present day Ayrshires.

Ayrshire cattle are uniform in their ability to produce milk and butterfat. While the average production is not as high as Holsteins, many high production records have been made in Canada. The world's champion butterfat producer, Ardgowan Valda, a cow imported into Canada from Scotland, was owned by F. C. Biggs, Dundas, Ontario. Her yearly record was 31,156 lb. of milk and 1,356 lb. of butterfat. The average test of Ayrshire milk is 4%. The fat globules are small, and this is regarded as an advantage in cheese making and for infant feeding. Ayrshires have, how-

ever, been criticized for the short lactation periods. This is being overcome by better breeding and feeding practices. Breeders claim that their animals are long lived, and lifetime records are encouraged to show how long Ayrshires can produce and reproduce efficiently.

They are of medium size, mature cows weighing between 1,100 and 1,300 lb., and bulls over 1,650 pounds. In general conformation Ayrshires show a compact body, a strong straight back, good in both shoulder and rump, and with a large barrel. They are lower set than the Holsteins. The udder is usually well proportioned and well attached to the body. Their well-balanced form and stylish carriage give them a very attractive appearance. Ayrshire cows in milk, when reasonably well fed, carry a fair amount of flesh, but do not appear beefy.

The color of Ayrshires is red and white spotted. The shade of red may vary from cherry to a reddish mahogany. Likewise there is a great deal of variability in the amount of red, from an almost solid red to an almost solid white. The lighter colored animals have a slight preference.

They are unsurpassed as grazers on rough sparse pastures. This may be the result of their early environment and active disposition. Ayrshires have splendid appetites and will consume large quantities of roughage. The heavier producing Ayrshire requires a fair amount of grain, but if too heavily fed will often become fat. While the disposition of the cow is good, some Ayrshire bulls are apt to become vicious and hard to manage when not properly handled.

The fact that Ayrshires are hardy and active, with the ability to rustle, makes them adapted to most parts of Alberta. While they have proven more suitable than the other breeds in the rougher and less fertile areas, they have also held their own in the better dairy districts of the province in competition with other breeds.

The Guernsey Breed

Guernseys were the last of the dairy breeds to be introduced into Canada. They are more popular in eastern Canada than in the western provinces. The number of these cattle in Canada is increasing rapidly. Guernseys are similar in many ways to Jerseys, having been developed under similar conditions in the Channel Islands. They are a little larger than Jerseys and produce slightly more milk with a little lower test. Their color is also of various shades of fawn, and instead of being mostly solid in color, all carry some white spotting. The Guernsey milk is more highly colored than the milk of any other dairy breeds, and this is due to its

higher carotene content. There is a tendency toward some coarseness in body conformation, and the udders are not as well proportioned and attached as are those of the Jerseys. Breeders are striving to correct the faults mentioned, and much improvement has already been accomplished.

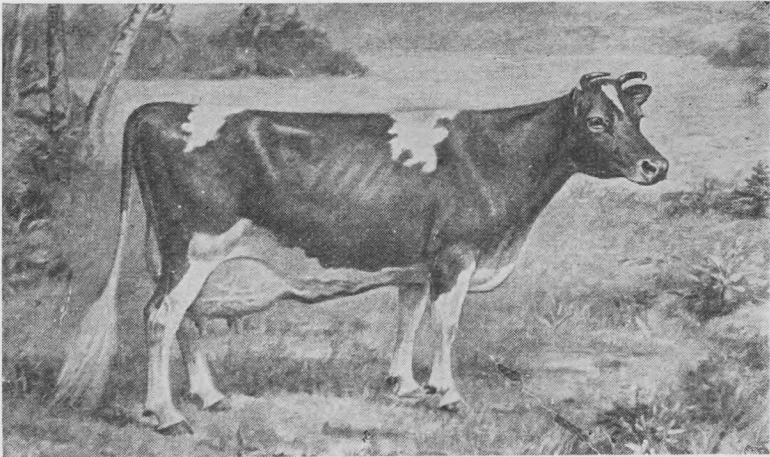


Fig. 4a—Model Guernsey Cow.

The breed is as well adapted to Alberta conditions as is the Jersey, and the successful raising of Guernseys in the province is dependent upon the continued improvement in the existing herds.

Dual Purpose Breeds

While it is admitted that dual purpose cattle are not as efficient producers of milk or beef as the specialized breeds, they may prove particularly useful in areas not suited for specialized dairying. These cattle can be recommended for farms where diversification is an important consideration. Dual purpose cattle are not, however, recommended for areas well suited to specialized dairying, as the lower income that would be secured from milk production would not be offset by the higher income from beef production.

The Red Poll and the dairy strain of Shorthorns are the two most popular breeds of dual purpose cattle in Alberta. Breeders of such cattle do not strive for as high production records as do breeders of specialized dairy cattle, since by so doing the beef qualities may be lowered. Although the number of purebred cattle of these breeds is relatively small, their beef quality is good, and many commendable production records have been made.

SELECTION OF DAIRY CATTLE

Proper Selection is Very Important.

The proper selection of dairy cows, heifers and bulls is of fundamental importance if the greatest profit in dairying is to be realized. Whether selection is for foundation animals to start a herd, for heifers to replace older or unprofitable cows, or to obtain a suitable bull, the choices made determine to a large extent the degree of success that will be attained in the dairy business.

There are several things necessary in properly selecting dairy animals, namely, an understanding of the ideal type, and ability to interpret and evaluate production records and pedigrees. Furthermore, it is necessary to understand how much importance should be given to each of these items in selecting any one animal.

How to be a Good Judge.

To be a good judge of dairy cattle requires not only a knowledge of what constitutes the ideal type, but also practical experience in handling stock. This experience helps one to observe and understand the degree of relationship that exists between production and conformation.

Knowledge of what constitutes general dairy type, together with the special breed-type standard adopted for each of the dairy breeds can be gained from the livestock journals and other publications, as well as at the livestock fairs. Each breed association has adopted a system of classifying cows according to type. This is not only an aid to selection, but educates the breeder in what constitutes breed type. This system is also used for classifying bulls according to a combined value for type as well as breeding, so that an officially classified bull would be one of suitable type and out of parents of good type and performance.

Production Records Important in Making Selection.

Selection can be made more accurate by giving some consideration to production records, as well as to type. This is because production is also an inherited characteristic and thus makes it possible for some cows of good type to be poor producers. Production is quoted in terms of milk as well as butterfat, but before these quantities can be properly evaluated, the conditions under which the records were made are needed. The age of the cow, times-a-day milked, and length of lactation period all affect production and must be considered in determining the producing ability of a cow most accurately.

Pedigree Study Aids Selection.

The consideration of an animal's pedigree also can make selection more accurate. Milk producing ability as well as type is transmitted from one generation to the next.

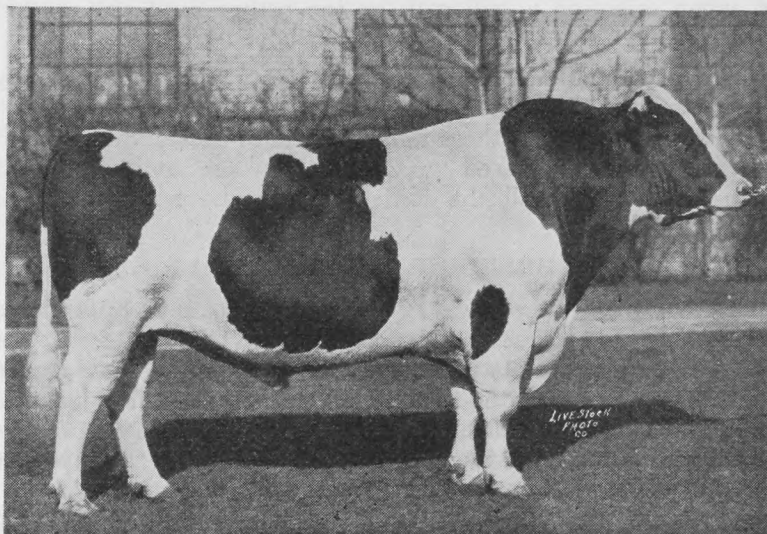


Fig. 5—Johanna Rag Apple Pabst, an outstanding show bull that has contributed greatly to the improvement of the breed through both sons and daughters.

When the animal to be selected is immature, its ultimate type and producing ability cannot be correctly judged by its appearance, since the animal is not fully developed. Because these characteristics are transmitted from generation to generation a knowledge of the type and production of its ancestors can be used as an indication of how the immature animal will develop.

The contribution of any ancestor to the inheritance of an individual is halved for each generation farther removed from the individual being considered. Ancestors three and four generations back on the pedigree contribute comparatively little to an animal's inheritance and therefore should not be given undue consideration. In making selection, therefore, it is most important to find out all one can about the immediate parents of an animal.

Pedigree Study Most Important in Selection of Young Animals.

The amount of consideration to give an animal's pedigree and how much to the individual type depends upon its sex, age and the amount of reliable information concerning the ancestors that is known. In selecting a mature cow, her type, mammary development and own performance are accurate indications of what she

actually can produce. A further study of her pedigree would, however, give an indication of what inheritance she would transmit to her offspring. In selecting a mature bull, the type and production of his daughters indicate accurately his breeding ability, and is much more reliable than the performance of his ancestors. However, when selecting a bull calf for the future herd sire, a great deal of consideration should be given to his pedigree.

Selection should therefore be based upon an individual's type and performance as well as its pedigree. The more accurately one knows about each of these items, the more consideration should be given to it. Increased production, income and profits are dependent on how well the individuals in the herd have been selected.

BREEDING PROBLEMS

Cows that freshen once every year produce more milk during a normal life than those that freshen at any other rate. In well established dairy districts it is desirable to have the cows freshen periodically throughout the year in order that the same quantities of milk can be shipped at all times. On the other hand, in other districts farm conditions may be such that it is desirable to have the majority of the cows freshen in the spring or in the fall.

Difficulties are often experienced in successfully breeding cows to freshen at the times planned. The cows either fail to come in heat or fail to become pregnant when bred. The failure of cows to come in heat or to become pregnant may be due to one of many causes, namely (1) diseases of the reproductive organs, (2) nutritional deficiencies, (3) abnormal reproductive organs, and (4) the bull may be an inefficient breeder.

Disease.

Contagious abortion (Bang's disease) and vaginitis are both caused by bacteria that invade the pregnant uterus and cause abortion any time following service. Retention of afterbirth often leads to infection of the uterus by necrotic bacteria. The infection from this cause may be so great as to make further reproduction impossible. Keeping the cows healthy by proper feeding, care and sanitation prevents breeding difficulties that are caused by disease. See section on diseases and treatments, pages 73 to 86.)

Nutritional Deficiencies.

Cows that are extremely thin due to improper feeding or because of heavy milk flow may fail to come in heat or to become pregnant. Cows must be in good health and thrift if their reproductive organs are to function normally.

When cows appear to be in fair flesh and good health but fail to come in heat or become pregnant, the trouble may be due to some specific vitamin or mineral deficiency. Injections of ascorbic acid (vitamin C) and the feeding of wheat germ oil have cured some nutritional causes of sterility. Lack of minerals such as calcium, phosphorus, iodine, iron and others has reduced the thrift of cows sufficiently to cause sterility.

Cows that are liberally fed good quality hays and grains with iodized salt and a simple mineral supplement should produce calves normally. There is also less possibility of a nutritional deficiency causing poor breeding when cows are on pasture. When cows are being properly fed and yet fail to get with calf, other causes for breeding difficulties should be explored.

Abnormal Reproductive Organs.

The abnormal development of the reproductive organs as well as their reduced or irregular activity may be inherited or may be caused by faulty nutrition. The failure of cows to have normal heat periods regularly, or their failure to conceive or give birth to a normally developed calf may be due to abnormal development or abnormal activity of the reproductive organs.

While nothing can be done to correct inherited abnormalities, improvement can be brought about when the trouble is caused by nutritional deficiencies. Cows in poor health, on account of some debilitating disease, and cows improperly fed sometimes fail to reproduce because a low hormone secretion will not allow the reproductive organs to function normally. Mature cows producing large quantities of milk may so deplete their nutrient reserves that their reproductive organs become inactive, and such cows may fail to come in heat until either milk flow is reduced or until they are fed sufficient of the required nutrients.

The hormones of several of the internal glands control the activity of the different reproductive organs. Breeding difficulties are sometimes caused by failure of these glands to secrete the hormones necessary for the normal functioning of the reproductive organs, and the injection of certain hormones has cured this form of sterility. Cystic ovaries often cause cows to remain in constant heat, and no reproduction is possible until the cysts have erupted or been broken down by mechanical treatment.

Twin calves are believed by some dairymen to be non-breeders when they reach maturity. Scientific studies have proven that it is only the twin heifer of a bull calf that is usually sterile. This is due to the fusion of the embryonic coverings of both calves which allows the blood streams of both to mix. The hormones

in the blood of the unborn bull calf prevent female reproductive organs developing in the twin heifer, causing permanent sterility. Such heifer calves should be either vealed or raised for beef, as only about one in twelve is likely to be fertile. When twins are of the same sex their reproductive organs develop normally and their full reproductive ability is attained.

Inefficiency of the Bull.

The failure of cows to become pregnant when conditions for normal reproduction appear satisfactory may be due to the bull being unable to produce normal semen. When a bull develops this inability, most or all of the cows bred to him will fail to get with calf, and will continue to come in season during the following heat periods.

There are many causes for bulls being unable to breed cows successfully. Overwork, lack of exercise, nutritional deficiencies and injuries are a few of the reasons why bulls become poor breeders. Most of these causes can be overcome by proper feeding and management.

Excessive use of the bull reduces the number and vitality of sperm cells. The semen of bulls used too seldom contains many dead sperm cells. Bulls confined to small stalls or kept in small pens without exercise may become slow breeders and may not be able to serve a cow properly.

Nutritional deficiencies may result in numerous breeding ailments of the bull depending on what is lacking in the ration. Feeding bulls too little feed, feeding rations low in proteins or the feeding of large amounts of silage may cause them to be slow and not dependable breeders. Specific mineral and vitamin deficiencies may also cause bulls to develop the same symptoms. The feeding of rations containing some legume hay or protein supplement should help in preventing bulls becoming unsatisfactory breeders. The injection of ascorbic acid and the feeding of wheat germ oil has been used with some success to correct specific deficiencies. Bulls sometimes injure their sex organs in fighting or in breeding cows. This may result in their indifference to the cows they should serve, or by the apparent failure to carry out the complete breeding act.

Artificial Insemination

In areas of high cow populations where communication facilities are well advanced, artificial insemination offers great promise for increasing the milk production of cows through the use of superior sires on a greater number of cows than is possible with natural breeding. With the greater use of better bulls, the number of average or inferior bulls may be reduced.

Under artificial insemination, the semen from a bull is collected in an artificial vagina. It is then tested for sperm cell vitality, is diluted, and small portions injected into or near the opening of the cervix of cows in heat. Under present-day methods of dilution it is possible to inseminate up to 500 cows with one ejaculate from a bull. The greatest difficulty is providing the organization to make possible economical utilization of the semen collected. Usually the bulls used in organized breeding associations are maintained at a central point where semen is collected and prepared for shipment to official inseminators at distant points.

Breeding cows artificially requires special equipment, and the collection, preparation and insemination of the semen requires technical and sanitary practices. For these reasons, only men specially trained for the work should be employed to perform the necessary operations in artificial breeding on the individual farms. Rules have been adopted by the purebred dairy cattle breeding associations governing the use of artificial insemination in purebred herds.

In addition to the advantages of using better bred bulls the use of artificial insemination may (1) reduce the number of services for each conception, (2) remove the necessity of keeping bulls for small herds of cows, (3) prevent or keep under control certain diseases, and (4) greatly improve the economic aspects of dairy husbandry through a material increase in milk production.

In order to make artificial insemination available to the livestock breeders, it was necessary that some organization assume the responsibility to properly organize a system for rendering this service.

In 1943 the Alberta Department of Agriculture established a breeding centre at the School of Agriculture, at Olds, from which semen of superior bulls can be distributed to breeders of purebred and grade cattle for artificial insemination.

Holstein-Friesian bulls of exceptional merit have been purchased in co-operation with the Holstein-Friesian Breeders Association. Rules have been adopted regarding the qualification of purebred females that can be inseminated and nominal fees have been established. Breeders of grade dairy cattle may also have their cows artificially bred by the formation of breeding clubs under the provisions of the Co-operative Associations Act and subject to certain supplementary regulations. Experience gathered by the work conducted in Alberta has shown that the best results have been secured in herds where the animals are kept in a healthy condition brought about by the use of good feeding and management practices, and where close supervision of the breeding program is maintained. Results have also been more satisfactory in herds

located where shipping and travelling facilities have been good, enabling the cows to be inseminated within the period when conception is most likely.

For these reasons the most successful artificial breeding has been done in purebred herds that were readily accessible, near the larger towns and cities. Service in breeding associations to grade cows has not proven as satisfactory in the prairie provinces because of sparse population and difficult travelling conditions. This is reflected by high cost and low conception rate.

Facilities are therefore available to the breeders of dairy cattle for utilizing artificial insemination and obtaining the benefits of this method of breeding.

FEEDING

Scientists have determined the nutrient requirements of dairy cows and the best means of providing those nutrients. We now know what nutrients the different feeds contain and how much of each the cow can utilize. Feeding trials have shown that when the proper principles of nutrition are applied, the maximum quantity of milk is produced and the feed is used most efficiently. Feeds are known to vary in their suitability for milk production and, of course, they also vary in price. If dairymen will use the information that is available to them, milk will be more efficiently produced and dairying will become more profitable.

Composition of Feeds

All feeds have been analyzed for the nutrients they contain. It is, therefore, of primary importance in feeding animals to know what nutrients are being fed, both as to kind and quantity. Feeds are analyzed for the following substances:

Moisture.—All feeds contain moisture. Green roughages, roots and the silages may have from 70% to over 90% moisture, while hays and grains vary around 10% depending on the moisture in the air and the length of time the feed is stored. The more moisture a feed contains, the lower will be the proportion of other nutrients.

Protein.—Proteins are complex chemical compounds that are of vital importance in the feeding of dairy cattle because they are most likely to be fed in insufficient amounts. Proteins are the only group of common nutrients that contain nitrogen. Feeds containing relatively large amounts of protein are sometimes described as nitrogenous. Milk, alfalfa hay and such feed by-products as linseed meal, wheat bran and shorts contain relatively large amounts of protein.

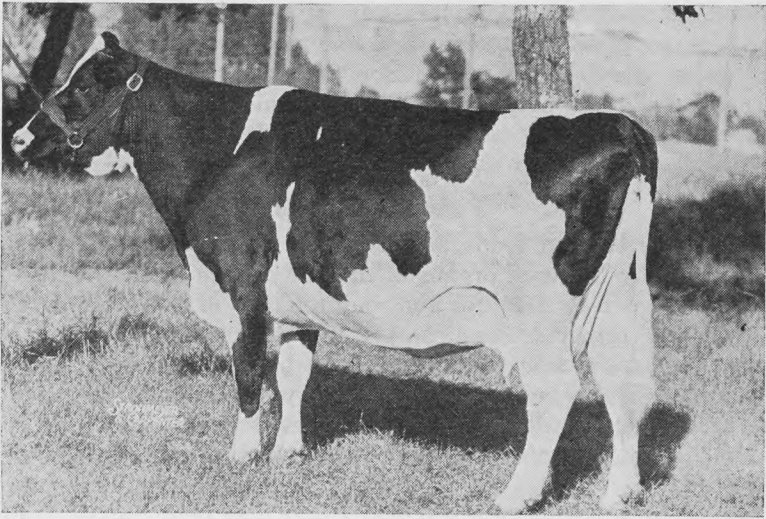


Fig. 6—A champion Holstein cow, Strathmore Koba Pearl Heilo, bred by C.P.R. Farm, Strathmore, Alberta.

Crude Fiber.—Crude fiber is the most indigestible part of any feed, and consists largely of celluloses and other similar substances that give rigidity and shape to plants. It is, therefore, high in such material as stalks and stems and lower in leaves and seeds. Feeds low in crude fiber and therefore high in digestible nutrients are called concentrates. Feeds high in fiber and therefore comparatively low in digestible nutrients are called roughages. Grinding roughages does not convert them to concentrates because the crude fiber content remains the same. Roughages with their high crude fiber content give bulk to the ration. In this connection it should be kept in mind that efficient feed utilization by cattle is only attained when there is ample bulk supplied.

Nitrogen-free extract comprises all the readily digestible feed substances other than fat, fiber and protein. Nitrogen-free extract consists largely of starches together with very small amounts of sugar. Feeds that contain relatively large amounts of nitrogen-free extract and smaller amounts of protein are called starchy, or more commonly, carbonaceous feeds.

Fats.—The fats in feeds are largely stored in the germ of the seed as a concentrated form of energy. Feed fats vary in hardness, and may have a definite effect on the quality of butter.

Ash.—When feeds are burned, the ash that remains contains the minerals of the feed. The bones, muscle, blood and milk of

animals contain relatively large quantities of minerals. Minerals must be supplied if animals are to grow, reproduce, lactate and remain in good health. Common salt, iodine and calcium, and occasionally phosphorus, are the minerals that are usually not obtained in sufficient quantities from the feed, and therefore must be supplied as supplements.

Function of Feeds

The nutrients in feeds are used (1) to supply energy for the work done by the vital organs of the body, such as the heart, lungs and digestive tract, (2) for the maintenance of body temperature, (3) for the repair of tissues, (4) for the building of new bone, muscle and fat tissues during the period of growth, pregnancy and fattening, (5) to provide the necessary ingredients required for the secretion of milk. In connection with every function of the animal body, specific amounts of the different nutrients are required.

For maintenance alone, the nutrient requirements are chiefly for nitrogen-free extract and fat with very little protein or minerals being required. The bigger the animal, the greater is the nutrient requirement. Exposure to extreme cold increases the requirement. Carbonaceous roughages alone can usually provide sufficient nutrients for maintenance.

Growth and pregnancy involve a building up of flesh and bone. These are largely composed of protein and mineral. The faster an animal grows, the greater will be the need for protein and mineral supplements. New born calves grow very rapidly, and as they become older their growth rate decreases, reducing their need for protein and minerals. Pregnant cows, therefore, require a little more feed than for maintenance alone.

Fattening requires a surplus of feed above other requirements. A dairy cow that fattens while producing milk is either getting too much feed or is using feed for body fat rather than for milk production. Fattening cows prior to freshening is sometimes practiced to increase milk production during the following lactation period. Thin cows may be fattened during their dry period by feeding an excess of carbonaceous or starchy feeds. Very little protein or minerals are required in this process.

Milk secretion calls for relatively large quantities of protein and minerals in the feed. Some cows have difficulty in eating and digesting sufficient feed to meet their requirements for milk secretion, because the inherent ability to produce milk has been increased to such high levels. So great is the nutrient requirement for heavy milk production that only by careful planning will the

ration provide the cows with the right amount of the required nutrients. A deficiency of any one nutrient will ultimately reduce milk production to the level at which the nutrient has been used up. Feeding lactating cows a ration containing a variety of palatable feeds reduces the possibility of certain deficiencies developing. The liberal feeding of a varied ration containing sufficient protein and minerals is essential for maximum milk production.

The rations for immature cows should contain the combined nutrients required for maintenance, growth, pregnancy, as well as for milk production, because they are still growing and are re-bred while still lactating.

Cows producing 25 lb. of 4% milk require almost twice as much feed as dry cows to meet their nutrient requirements. This extra feed for milk production must be provided chiefly in the form of a concentrate mixture, because cows are limited in the amounts of roughage they can consume.

Yearly Feed Requirements for Dairy Cattle.

The following outline shows the amounts that should be provided for dairy cattle to ensure an adequate supply of feed on a yearly basis for each individual in the herd. It has been calculated to show the feed requirements of an average cow of 1,200 pounds live weight, producing approximately 4% milk. In using this table consideration should be given to herds that vary materially in weight and butterfat test from average.

It should be kept in mind that dairy cows in milk require large quantities of hay, grain, protein supplement and minerals. The greater the milk production, the greater is the feed requirement.

Roughage.

Three tons, plus adequate grazing during the pasture season.

Pasture.

2 to 2½ acres cultivated pasture in high productive areas with good soil and ample rainfall.

3½ to 4 acres cultivated pasture in medium productive areas with only fair soil and rainfall.

1 acre of good irrigated pasture.

3 acres native pasture or 10 acres bush land equal 1 acre cultivated pasture.

Minimum pasture requirements should only be provided when good management and rotational grazing are to be followed.

Concentrates.

Level of Production	Pounds milk per cow	Grain required with summer pasture (no supplement)	Grain required with winter feeding (no supplement needed with legume hay)	Amounts of a 24% protein supplement that should be included as a portion of the grain when a mixed hay or a grass or cereal hay (oat bundles) is fed.	
				Mixed hay	Grass or Cereal hay
Low	4500-5500	0 lb.	900 lb.	0 lb.	150 lb.
Med.	5550-7500	200 lb.	1,800 lb.	300 lb.	600 lb.
High	7500-9000	500 lb.	2,200 lb.	350 lb.	700 lb.

Example: Cows of medium production being fed brome hay would require a total concentrate mixture of 1800 lb. composed of 1200 lb. grain and 600 lb. protein supplement during the winter feeding period..

Note: The 24% protein supplement can consist of 2 parts wheat bran and 1 part linseed meal.

Where it is the practice of having the majority of the cows calve in the spring there will be a reduction of protein supplement required, and there will be a larger proportion of the total grain fed on pasture.

Minerals.

40-60 lb. salt containing 1 oz. potassium iodide per cow per year. When no legume hay is fed 1% bonemeal should be added to the grain mixture of high producing cows.

Bedding.

1800 lb. per cow per year in a stanchion barn.

3600 lb. per cow per year in a loose housing barn.

Young Stock Requirements.

Calves:

Milk, skimmed and whole—1440 lb. ($\frac{1}{4}$ wholemilk and $\frac{3}{4}$ skimmilk).

Grain—900 lb.

Hay—1800 lb.

Pasture—from four months on.

Yearlings:

Hay—3600 lb.

Grain—1000 lb.

Pasture—as for milking herd.

Nutritional Value of Feeds

The nutritional value of a feed is based upon how well it satisfies the nutrient requirements of an animal. A chemical analysis of a feed shows the percentage content of the various nutrients, but does not show how much of these are digestible. Neither does it show a feed's palatability, vitamin or mineral content, or the presence of injurious substances. Nevertheless, the chemical analysis is used by law as a basis of commercial feed evaluation. The Feeding Stuffs Act provides that all commercial feed mixtures and feed by-products offered for sale shall be accompanied by a

statement guaranteeing that the crude fiber is not greater than the percentage stated, and that the crude protein content is not less than the percentage stated. Knowing the fiber content enables one to understand approximately how much of the feed is indigestible, and a knowledge of the protein content is likewise important because it cannot be replaced by either carbohydrates or fat. The Act also provides that a statement be given guaranteeing a minimum percentage of fat for most feeds. Since excess fat is not desirable, commercial feeds that tend to be over 7% fat must be labeled with a statement showing the maximum fat content.

TABLE 1.

Average Percentage of Digestible Nutrients in Feeding Stuffs*

Feeding Stuff	Total Dry Matter %	Dig. Protein %	Total Dig. Nutrients %	Nutritive Ratio 1:
Dry Roughages.				
Alfalfa hay, all analyses	90.5	10.5	50.3	3.8
Alfalfa meal, good	92.7	11.8	53.6	3.5
Alfalfa straw	92.6	4.5	42.6	8.5
Barley hay	90.8	4.0	51.9	12.0
Barley straw	90.0	0.7	42.2	59.3
Brome grass hay, all analyses	88.1	5.0	48.9	8.8
Clover hay, alsike, all analyses	88.9	8.1	53.2	5.6
Clover hay, alfaswede	88.0	6.8	52.0	6.6
Clover hay, sweet, second year	90.7	9.4	47.3	4.0
Oat hay	88.1	4.9	47.3	8.7
Oat straw	89.7	0.7	44.7	62.9
Prairie hay, western, good quality	90.7	2.1	49.6	22.6
Red top hay	91.0	3.2	48.7	14.2
Reed canary grass hay	91.1	4.8	45.1	8.4
Timothy hay, before bloom	89.0	5.4	56.8	9.5
Timothy hay, full bloom	89.0	3.3	48.1	13.6
Wheat grass hay, slender	90.0	4.6	51.2	10.1
Wheat straw	92.5	0.3	40.6	134.3
Roots and Tubers.				
Potatoes, tubers	21.2	1.3	17.9	12.8
Turnips	9.3	0.9	7.8	7.7
Silages.				
Oat	28.3	1.1	15.4	13.0
Sunflower	22.6	1.0	12.2	11.2
Concentrates.				
Barley	89.4	10.0	77.7	6.8
Beet pulp, dried	90.1	4.3	67.8	14.8
Beet pulp, wet	11.6	0.8	8.8	10.0
Brewers' grain, wet	23.7	4.2	16.1	2.8
Flaxseed	93.8	21.8	108.3	4.0
Linseed meal, old process, all analyses	91.0	30.8	77.2	1.5
Meat scraps or dry rendered tannage, 60% protein grade	93.8	49.9	69.6	0.4
Molasses, beet	80.5	4.4	60.8	12.8
Oats	90.2	9.4	70.1	6.5
Skim milk, centrifugal	9.5	3.4	8.7	1.6
Wheat, hard spring	90.1	13.3	80.7	5.1
Wheat bran, all analyses	90.1	13.7	67.2	3.9
Wheat screenings, good grade	90.4	10.0	68.7	5.9
Wheat standard middlings	89.6	15.0	77.2	4.1

*Taken by special permission of the Morrison Publishing Co., Ithaca, New York, from the extensive data in "Feeds and Feeding," 21st Edition, by F. B. Morrison.

The nutritional value of a feed is more accurately calculated by determining the quantity of the various nutrients that are digestible. Numerous digestion trials have been conducted with cattle fed the various kinds of feeds. The average digestible protein and total digestible nutrient content in 100 pounds of feed shown in Table I is based upon results of these trials. The table also shows the ratio of digestible protein to the other digestible nutrients to indicate the relative proportion of digestible protein in each feed.

The calculating of balanced rations is largely based upon the digestible nutrient content of feeds.

What is a Suitable Ration?

Not all rations calculated to meet the protein and energy requirements are suitable. They may be deficient in other nutrients, may provide insufficient bulk, or cows may refuse to eat the ration. A good deal of thought has to be given to the choice of feeds that are to be included in the ration to make it suitable.

Rations to be suitable must contain:

1. Sufficient protein and digestible nutrients to meet requirements.
2. A variety of feeds, so that protein, mineral and vitamin content of one will offset the deficiencies of another.
3. Feeds that are palatable so the animals will consume their full daily allowance.
4. Sufficient bulk to maintain efficiency of digestion.
5. Feeds that supply the required nutrients at a low cost.

Rations should also be slightly laxative.

Suggested Concentrate Mixtures.

Herd concentrate mixtures will be largely determined by the roughages which are being fed and also by the concentrate feeds available. Sample herd concentrate mixtures that will meet the requirements of dairy cows on different kinds of hay are shown in the following table.

TABLE II.
Suggested Herd Concentrate Mixtures
17% Protein Mixtures

A.—For cows fed only grass or cereal hays:	1 lb.	2 lb.	3 lb.	4 lb.	5 lb.
Oats	585	725	625	550	560
Barley				170	280
Wheat			100		
Wheat Screenings	240				
Wheat Bran		100		100	72
Shorts			100		
Linseed Meal	175	175	175	180	
Meat Scraps					88
	1,000	1,000	1,000	1,000	1,000

14% Protein Mixtures

B.—For cows fed roughages composed of about one-third alfalfa and two-thirds grass or cereal hays:

	6 lb.	7 lb.	8 lb.	9 lb.	10 lb.
Oats	560	900	660	650	765
Barley	280		190	190	
Wheat					215
Wheat Screenings	135				
Wheat Bran		100		160	
Shorts			150		
Linseed Meal	25				20
	1,000	1,000	1,000	1,000	1,000

13% Protein Mixtures

C.—For cows fed roughages composed of about two-thirds alfalfa and one-third grass or cereal hays:

	11 lb.	12 lb.	13 lb.	14 lb.	15 lb.
Oats	900	800	800	700	700
Barley		150	100	290	100
Wheat	100		100		
Wheat Screenings					200
Wheat Bran		50			
Linseed Meal				10	
	1,000	1,000	1,000	1,000	1,000

Commercial Feeds.

Commercial feed companies are selling mixed protein supplements which when added to certain amounts of ground grain form suitable mixtures containing amounts of protein similar to that recommended in the above suggested grain mixtures.

For example: If 100 pounds of a mixed protein supplement with a guarantee of 24% protein is mixed with 200 pounds of a mixture of two-thirds oats and one-third barley, the resulting 300-pound mixture would contain approximately 16% protein.

To make a concentrate mixture containing	Mix 100 lb. of a 24% mixed protein supplement with the following amounts of ground oats and barley	Mix 100 lb. of a 32% mixed protein supplement with the following amounts of ground oats and barley
17% protein	140 lb.	300 lb.
16% "	200 "	400 "
15% "	300 "	567 "
14% "	500 "	900 "
13% "	1,100 "	1,900 "

Thumb Rules for Feeding.

For roughage.—On the average, cows will consume at least 2 lb. of roughage daily for each 100 lb. live weight. They will eat more roughage when it is of good quality and palatable. The more roughage of good quality cows will eat, the less of the concentrate mixture will be required. While full feeding of hay is recommended, cows are unable to eat much over 2½ lb. daily for each 100 lb. live weight when no grain is fed, or much over 2 lb. when grain is heavily fed. Silage can replace hay at the rate of 3 lb. for each pound of hay.

TABLE IIIa.

Grain Feeding Table for Cows Not on Pastures*

Hay equivalent consumed per 100 lb.
of live weight daily

2½ lb. very liberal feeding of good roughage	2 lb. usual rate of feeding good hay or good hay and silage	1½ lb. feeding scanty amt. of good roughage or feeding poor roughage	Total pounds of grain or concentrates to feed					
			% of fat in milk					
Milk produced lb.	lb.	pounds lb.	3.5% lb.	4.0% lb.	4.5% lb.	5.0% lb.	5.5% lb.	6.0% lb.
17	10	.....	.....	.....	1.9	2.2	3.1	3.5
21	14	.....	2.0	2.4	3.8	4.2	5.3	5.7
25	18	11	3.6	4.2	5.6	6.2	7.4	8.0
29	22	15	5.2	5.9	7.5	8.2	9.5	10.2
33	26	19	6.8	7.6	9.3	10.2	11.6	12.5
37	30	23	8.4	9.3	11.2	12.2	13.7	14.7
41	34	27	10.0	11.1	13.1	14.2	15.8	17.0
45	38	31	11.6	12.8	14.9	16.1	18.0	19.2
49	42	35	13.2	14.5	16.8	18.1	20.1	21.5
53	46	39	14.8	16.3	18.7	20.1	22.2	23.7
57	50	43	16.4	18.0	20.5	22.1	.....	.....
61	54	47	18.0	19.7	22.4	.....	.....	.....
65	58	51	19.6	21.4	24.2	.....	.....	.....
69	62	55	21.2	23.2	.....	.....	.....	.....
73	66	59	22.8	24.9	.....	.....	.....	.....

Regardless of the amount of grain theoretically required by a cow, she should not be fed more than she can safely handle.

Example: a cow receiving the usual allowance of good hay and producing 30 pounds of 4.5% milk should be fed 11.2 pounds of concentrates daily.

*Taken by special permission of the Morrison Publishing Co., Ithaca, New York, from the extensive data in "Feeds and Feeding," 21st Edition, by F. B. Morrison.

TABLE IIIb.

Grain Feeding Table for Cows on Pasture*

Quality of Pasture			Total pounds of grain or concentrates to feed					
Excellent	Good	Fair	% of fat in milk					
Milk produced lb.	lb.	lb.	3.5% lb.	4.0% lb.	4.5% lb.	5.0% lb.	5.5% lb.	6.0% lb.
22	13	.....	.....	.....	.....	.....	.....	1.2
26	17	.....	.....	.....	1.9	2.2	3.1	3.5
30	21	12	2.0	2.4	3.8	4.2	5.3	5.7
34	25	16	3.6	4.2	5.6	6.2	7.4	8.0
38	29	20	5.2	5.9	7.5	8.2	9.5	10.2
42	33	24	6.8	7.6	9.3	10.2	11.6	12.5
46	37	28	8.4	9.3	11.2	12.2	13.7	14.7
50	41	32	10.0	11.1	13.1	14.2	15.8	17.0
54	45	36	11.6	12.8	14.9	16.1	18.0	19.2
58	49	40	13.2	14.5	16.8	18.1	20.1	21.5
62	53	44	14.8	16.3	18.7	20.1	22.2	23.7
66	57	48	16.4	18.0	20.5	22.1	.....	.....
70	61	52	18.0	19.7	22.4	.....	.....	.....
74	65	56	19.6	21.4	.....	.....	.....	.....

Regardless of the amount of grain theoretically required by a cow, she should not be fed more than she can safely handle.

Example: a cow on excellent pasture and producing 30 pounds of 4.5% milk should receive 3.8 pounds concentrates daily.

*Taken by special permission of the Morrison Publishing Co., Ithaca, New York, from the extensive data in "Feeds and Feeding," 21st Edition, by F. B. Morrison.

For concentrates.—There are three separate rules that can be used as guides for the feeding of concentrates:

1. Feed 1 lb. concentrates daily for each 3 to 4 lb. of milk, depending upon the test of the milk. For cows producing

milk under 4% butterfat, 1 lb. of concentrates for each 4 lb. of milk is usually sufficient.

2. Feed 1 lb. concentrates daily for each pound of butterfat produced in a week. While this method is a little more accurate, it necessitates periodic testing of the milk to enable calculation of the weekly butterfat production.
3. Feed concentrates according to a plan which takes into account the amount of hay fed, or quality of pasture as well as the test of the milk produced, as is shown in tables IIIa and IIIb.

Roughages

Comparing pasture, hays and grain, pasture is the cheapest source of the required nutrients, followed by the hays and lastly the grains. The districts best adapted to dairying are those which can produce an abundance of crops suitable for pasture or hay. It follows that cows which consume large quantities of hay will be the most economical producers. Hay crops should therefore be given more consideration than grain crops in planning the feed supply for dairy cows. Cows in milk should receive all the hay they will consume without undue waste, and be fed sufficient of a concentrate mixture to provide the balance of the nutrients required.

Hays Vary in Composition.

Hay when cut at the immature stage contains larger amounts of protein than when more mature. It is also less coarse and is more palatable. It is therefore advisable to cut hays before the crop becomes too ripe, coarse and unpalatable.

The curing of hay affects its feeding value. Too much exposure to sun, leaching by rain, or spoilage by dampness in storage may reduce its value as a feed by as much as one-third.

Legume hays, grass hays and cereal hays differ in their nutrient content. Legume hays are richer in protein and minerals than grass hays. Cereal hays contain the least calcium (lime) and cereal straws are too low in feed value for use in rations of cows in milk. Dairymen should therefore strive to grow the most nutritive hays and to prevent any loss of nutrients during the curing process.

Legume Hays Are the Best.

As a group, legume hays normally contain more protein and minerals than other hays. They are more palatable, and in addition help to maintain soil fertility and prevent soil erosion.

Alfalfa is recommended as the best of all hays for the feeding of dairy cattle. The high protein and calcium content of alfalfa hay decreases the necessity of feeding the higher priced protein and calcium supplements. When alfalfa of good quality comprises

one-half of the roughage, it will provide sufficient protein even in the case of high producing cows. In feeding practice this would mean that the linseed meal and bran could be eliminated from the concentrate mixture.

Alfalfa hay should be reserved for cows producing the most milk, because the nutrient requirement of dry and low producing cows can be obtained from the less nutritious roughages.

Alfalfa is adapted to a wide range of soil types, but it does not thrive on poorly drained soil, nor in soil that does not contain a fair amount of lime. Alfalfa requires a reasonable amount of moisture, and should be grown where there is a fair amount of precipitation or on irrigated land where soil moisture can be regulated. Good yields are secured in years of favorable rainfall and two crops can usually be cut. The first cutting is usually coarser and less nutritious than the second cutting, and contains a lesser amount of digestible crude protein and total digestible nutrients.

Sweet clover is similar in composition to alfalfa, but it makes a much coarser and less palatable hay. Nevertheless, by early cutting and careful curing a good, very suitable hay crop can be produced. Sweet clover is adapted to drier conditions than alfalfa or other legume hay crops. It is a biennial, being used as a cover crop the year of seeding and a hay or pasture crop the following year.

Red clover (Altaswede) is very palatable and relished by dairy cattle of all ages. While it contains only two-thirds the digestible crude protein of alfalfa, it is just as rich in total digestible nutrients. Altaswede clover requires a soil which is well drained, free from alkali, and not too strongly acid. It is adapted to the black and woodland soils, and to the irrigated sections. The Altaswede variety is a perennial, whereas other varieties of red clover are biennials.

Alsike clover is similar to red clover in feeding value, but is not quite as palatable. It is adapted to quite moist conditions and consequently grows well, especially in gray woodland soils and adjacent black soil areas. It will thrive well on the heavier soils and on lighter soils if the moisture conditions are adequate and if sufficient lime is present.

Perennial Grass Hays

The grass hays most common in Alberta are timothy, brome grass, crested wheat grass, red top, upland prairie, slender wheat-grass (Western rye), and Reed canary grass. These hays vary in composition, palatability and other characteristics, thus making them differ in their suitability for dairy cattle. All grass hays vary

greatly in composition according to the stage of maturity at which they are cut. This affects their value in dairy cattle feeding. Each of these is adapted to a particular set of conditions, moisture supply being the chief factor which determines the localities in which they will thrive.

Timothy hay, providing it is cut before it reaches the full bloom stage, and is properly cured, can be satisfactorily fed to dairy cattle. It grows best in parts of the province where moisture conditions are good, and on irrigated land. It thrives better on cold wet soils of the heavy types than some of the other grasses, and although it endures considerable drought, it yields poorly under dry conditions. Timothy hay cut before bloom contains about 70% more protein than when cut in full bloom. For dairy cattle feeding it is advisable to cut timothy hay prior to full bloom in order to preserve a larger proportion of its protein as well as its palatability.

Brome grass is one of the more common crops grown for hay and pasture. It is a fairly nutritious hay when cut before becoming coarse and unpalatable and when well cured. Brome is extremely winter hardy and usually yields well. Because brome becomes sodbound, it is not advisable to use it as a hay or pasture crop for too long a time.

Slender wheatgrass (western rye) is a native type of bunch grass that makes a fairly nutritious hay for dairy cattle. It is winter hardy and grows wild under limited moisture conditions. Because it is subject to certain root rot to which the wheat plant also is susceptible, it should be seeded in a rotation which will not jeopardize a subsequent wheat crop.

Crested wheat grass is more suitable for the drier districts in the province. It is fairly nutritious and well liked by dairy cattle. Although it can be grown in central and northern Alberta where moisture is more plentiful, other better yielding and more palatable hays should be grown in areas of good rainfall.

Red Top hay is as nutritious as most other grass hays, but lacks somewhat in palatability. It grows well in marshy and moist soils and will grow on soils too acid for most other grasses. It is hardy and will withstand considerable drought. While these facts may favor the growing of red top in certain districts, the growing and feeding of this hay crop is not recommended for dairy cows when other more suitable hays are available.

Upland Prairie hay of good quality for feeding dairy cattle is becoming less plentiful. The best and most nutritious prairie hay consists wholly of the finer grasses, cut green and well cured, containing little or none of the coarser slough grasses or dead remains of previous years' growth. The lower grades of prairie hay are

extremely low in feeding value and cannot be recommended as a suitable hay for dairy cows.

Reed canary grass is coarse, unpalatable and lacking in feed value. When fed to cows in heavy production, an extra allowance of grain should be fed to offset the lower nutritive value of this hay. This grass can be grown in low-lying areas that are subject to periodic flooding.

Annual Grass Hays

These include the cereal hays such as oat, barley, wheat and rye hays. Early cut cereal hays are relished by cattle. As the crop ripens, the straw becomes coarse, unpalatable, and less digestible. Dairy cows should not be forced to consume the ripened butts of these hays unless hay is extremely scarce. Cereal hays are low in calcium, and mineral supplements should be fed when these hays are the sole roughage. They vary greatly in palatability and nutritive value, depending on the stage of maturity when cut. Cereal hays are usually grown when insufficient quantities of legume or perennial grass hays are available.

Oat (greenfeed) hay is the most commonly grown cereal for hay in central and northern Alberta. The yields are usually good, and when cut early it is relished by dairy cattle. Experiments conducted at the University of Alberta comparing an oat hay-grain-protein supplement ration with an alfalfa-grain ration without protein supplement proved that while milk production could be maintained almost as well with the oat hay ration, the cost of the protein supplements increased the cost above that of the alfalfa hay ration. Oat hay proved to be worth not more than 60% as much as alfalfa for cows producing over 35 lb. of milk daily. Had the protein supplement not been added to the oat hay ration, the value of oat hay would have been less.

The cutting of oat hay when still green or cut not later than the early milk stage is recommended for dairy cows in milk, whereas oat hay cut when more mature is more suitable for dry cows.

Barley hay is likewise a palatable and nutritious cereal hay when it is cut green and well cured. There is some objection to the awns which become increasingly detrimental as the barley crop ripens. Awnless barley is a much more suitable hay crop to grow, and is increasing in popularity. Barley hay, while not yielding quite as well as oat hay, is slightly higher in digestible protein and total digestible nutrients.

Cereal Straws

Cereal straws are not recommended for dairy cows in milk as they are less palatable and much lower in feed value than any of

the hays. They may be used to a limited extent for dry cows and heifers if a suitable concentrate mixture is fed to keep them in a fair condition of flesh.

Oat and barley straws are the best of the cereal straws. Where there is a shortage of other hays these straws may be fed in limited amounts providing additional grain is fed to offset the deficiencies of the straw. Awned barley straw should not be fed as the awns are likely to cause sore mouths. The awnless barley straw is a much safer feed.

Wheat and rye straws are the least palatable and lowest in feed value of all straws, and are therefore not recommended as a feed for dairy cattle.

Mixed Hay Crops Are Desirable

The feeding of more than one hay adds variety to the ration and often provides a more suitable supply of feed nutrients. The seeding of mixed hay crops results in greater yields than the growing of separate hay crops, and is a much simpler way of feeding a variety of hays. In these mixed crops it is desirable that at least one grass and one legume be grown, the kinds being carefully chosen to suit the climatic and soil conditions. Often a simple mixture of brome and alfalfa has proven to be a good mixture either for hay or for pasture.

Root Crops and Tubers

Succulent feeds are very palatable and suitable for dairy cattle feeding. Because the cost of producing these crops is relatively high, they are very seldom grown as a crop for the dairy herd except for cows on test, or fitting animals for showing. Occasionally, however, due to a low market price, or danger of spoilage such crops can form an important part of the dairy cow ration.

Silages

Silages are also succulent feeds that are highly desirable for dairy cows during the winter. Silage feeding offers several advantages. Green crops can be stored in a silo in a smaller space and with less loss in feed value than the same crop cured as hay. Weedy crops can be best utilized as ensilage. Under average farm feeding conditions, the addition of ensilage to an otherwise dry ration will usually increase production. However, recent experiments have shown that when a suitable balanced ration is being fed, and when water is available at all times, the addition of ensilage to the ration will produce very little or no increase in production.

Excellent grass and legume silages have been produced when 100 to 200 pounds of ground grain or 60 to 80 pounds of molasses are

added to each ton of crop at time of ensiling. The superior nutritive qualities of legumes are not lost by ensiling and cows fed these silages produce milk of higher vitamin content.

Considerable study is also being given to the reduction of ensiling costs and methods for securing silage of high quality. The building of trench silos, the use of new type machinery and the addition of preservatives have given some encouragement for a wider use of silage on the dairy farms of the province.

Oat silage.—Where corn cannot be grown for silage, oats can be used to advantage. It is the most nutritious and most suitable silage for most parts of Alberta. It is palatable and mature cows will readily consume from 30 to 40 lb. per day. Freezing in an upright silo does not make its removal from the silo more difficult. The oat crop is usually cut in the early dough stage, and when ensiled at this stage of maturity will usually make good quality ensilage. However, if cut at an earlier stage, or if it contains a large quantity of weeds, ensilage that is high in acetic acid, or that is acrid or putrid, may develop. Such undesirable silage can be avoided by the addition of 20 to 30 lb. of molasses per ton of oats when being cut into the silo.

Sunflower silage is a less desirable ensilage, even though heavier yields can be grown per acre. It is a palatable silage which usually contains a little more moisture than oat silage. Experiments conducted at the University of Alberta have shown that on a dry matter basis, the nutritive values of these two ensilages are equal. An objection to sunflower ensilage lies in the difficulty in using the silage after it has been frozen in an upright silo. It is not only difficult to remove the frozen silage from the silo, but such ensilage requires several days to thaw out at barn temperature. Such difficulties can be overcome by ensiling in a trench or pit silo.

Alfalfa, sweet clover, and grass silages of good quality have been secured most often when sufficient preservatives have been added and the crop has been wilted to about 70 or 75% moisture. More mature crops require the addition of less ground grain or molasses than immature crops.

Concentrates

It is impossible for cows producing over 15 or 20 lb. of milk per day to satisfy their nutrient requirement from hay alone or from a mixture of hay and silage. Such animals must receive additional nourishment in concentrated form from feeds having a low fiber content and high nutritive value. This concentrate feed must also provide the nutrients which may be lacking in the roughage so that the entire ration satisfies all the nutritional requirements

of the animals. While the cereal grains usually comprise the major part of the concentrate mixture, the addition of protein rich feed by-products, together with certain minerals, is often required to provide a properly balanced ration.

The different grains and feed by-products vary greatly in composition, palatability and in their usefulness for milk production, growth and fattening. A brief comment on a few of the concentrate feeds follows.

Cereal Grains.

All the cereal grains are slightly carbonaceous and the addition of some protein supplement is necessary when grass or cereal hays are being fed. The grains are low in calcium, and for this reason mineral supplements are usually fed to the heavy producing cows. The grains should be coarsely ground or crushed.

Oats is the most desirable of all the grains for dairy cattle of all ages. It is very palatable and usually contains a larger proportion of digestible protein than the other cereal grains. It should comprise the main part of all concentrate mixtures for growing heifers as well as cows in milk.

Barley is a very suitable grain for dairy cattle feeding. It is palatable and usually contains slightly more total feed nutrients than oats and is slightly more carbonaceous. Barley is a heavier grain and tends to be fattening when fed in too large a quantity. However, when fed with suitable other feeds it has proven to be quite satisfactory for cows in milk.

Wheat is not as suitable as oats or barley for feeding cows in milk. It is still less suitable as a feed for young stock. Wheat is much heavier and may cause digestive disorders. Nevertheless it has been fed successfully as the sole concentrate by some dairy-men to cows of average production. In experiments at the University of Alberta, concentrate mixtures containing 60% wheat have proven as good as concentrate mixtures containing no wheat. In these experiments, however, the heavy wheat ration was fed with the silage to offset the undesirable properties of wheat. The mixing of other light concentrates or chopped hay with the wheat has the same effect. Usually the price of wheat is high compared to the other grains, in which case its feeding is an uneconomical practice.

Rye is the least suitable of the cereal grains for dairy cattle. While its nutritive value may be equal to or better than the other grains, it is less palatable, and cows requiring a heavy grain allowance may refuse to consume sufficient quantities if the proportion of rye is too large.

By-product concentrates.

These vary greatly in composition and suitability. Some are rich in protein and are most useful as a supplement to carbonaceous feeds. Other by-products are carbonaceous and have to be fed with protein rich feeds. None of the following feeds are used as the sole concentrate, but only form a part of the concentrate mixture. Because the by-products vary in price, their purchase should be based largely upon their composition and feed value.

Beet pulp is a carbonaceous by-product of the sugar beet refineries. It is a bulky feed containing a fair amount of fiber. It is slightly laxative and has the effect of maintaining the appetite of heavily fed test cows. Refineries also produce a dried beet pulp to which molasses has been added. This is called molasses beet pulp and is similar to oats in feeding value.

Wet Brewers' Grains are rich in protein, are succulent and well liked by dairy cows. They are fairly bulky and contain slightly more fiber than most concentrates. On a dry basis, brewers' grains contain less digestible nutrients than oats. They may be fed up to 40 lb. daily. Special arrangements have to be made on the farm for storing and feeding brewers' grains, as they may become sour during warm weather when stored too long. Brewers' grains have proven to be a cheap protein-rich feed for dairymen located reasonably close to breweries.

Flaxseed is grown chiefly for the linseed oil it contains. After the oil has been extracted, the residue is available as linseed meal, which contains approximately 50% more digestible protein than flaxseed. Flaxseed is, therefore, less valuable as a protein supplement than linseed meal. Flaxseed meal is most valuable when fed to young stock to promote normal growth and thrift. It has a laxative effect and acts as an aid to digestion. Because it has the effect of adding a sleekness and bloom to the appearance of animals, flaxseed meal is used by breeders of purebred stock, and by showmen for these special properties rather than for its nutritive value. In years of normal feed prices, flaxseed meal is usually more expensive than linseed meal, and dairymen would be advised to sell their flax and purchase the linseed meal derived from it.

Linseed meal—the by-product of flaxseed after the oil has been extracted—is one of the most suitable protein-rich supplements for milk production. As previously mentioned, it contains about 50% more digestible protein than flax and over three times the protein of oats or barley. Linseed meal is palatable and has a desirable laxative effect, which helps in maintaining the animals in good thrift.

Meat meal or meat scraps is similar to digester tankage except that it is higher in protein and does not have as strong an odor. It is the richest protein supplement used in dairy cattle feeding, and therefore less is required to balance carbonaceous feeds. Cows usually do not like meat scraps at first, but if small quantities are fed the amounts can be increased to the full allowance desired. Certain batches of meat scraps may prove more unpalatable than others.

Beet molasses is definitely a carbonaceous feed, a by-product of sugar beet refineries. Its feeding value is dependent upon its sugar content, which makes beet molasses a very palatable feed. Experiments have shown that, pound for pound, it is worth 80% as much as oats in nutritive value. This figure can be used to calculate how much one can afford to pay for molasses as a feed. Sometimes it is used to increase the consumption of less palatable feeds. In such cases molasses is diluted with two parts of water and poured over the unpalatable feed, usually a roughage. Molasses has proven to be a cheap feed in areas surrounding a sugar refinery, but freight charges to distant points may increase the total cost to such an extent as to make its use uneconomical.

Wheat bran is probably the most widely used protein-rich supplement in dairy cattle feeding. While it only contains about 43% as much protein as linseed meal, wheat bran has proven of special value for purposes other than its protein content. It is especially useful in lightening concentrate mixtures and during periods when there is danger of digestive disorders. The feeding of warm bran mashes before and after calving is highly recommended for maintaining health during this critical period. Wheat bran appears to have the effect of stimulating milk secretion and possesses a higher feeding value than is indicated by its digestible nutrient content. It contains large amounts of phosphorus and vitamins that are required by both growing and lactating animals. Wheat bran is also an excellent feed for calves and heifers.

Recleaned wheat screenings as sold in Canada under the Grain Inspection Act are classified in two grades—No. 1 containing no more than a total of 6% and No. 2 no more than 10% total weed seeds, and neither grade containing sufficient weeds of the kind that may be injurious to livestock. Their feeding value is determined largely by their weight per bushel—the better grades would compare favorably with barley and wheat in feeding value. Screenings should be ground finely enough to kill all weed seeds. Wheat screenings, when available, can usually be purchased at prices which make them a cheap source of nutrients for feeding dairy cows.

Uncleaned wheat screenings vary in composition and in feeding value according to the maturity of the wheat kernels as well as to the amount of chaff and other material present. The fact that these screenings may contain large quantities of weed seeds of various kinds may mean that such screenings may be unpalatable. Screenings that are fairly light in weight have a low feeding value but can be satisfactorily fed to young stock and dry cows. These screenings can also be used to lighten an otherwise heavy concentrate mixture.

Wheat standard middlings or shorts are suitable dairy cattle feeds if not forming too large a part of the concentrate mixture. While these feeds contain fair amounts of protein, experiments have shown that they are not as suitable as wheat bran for feeding cows in milk. Wheat middlings or shorts are much heavier than bran, and should not be used in an otherwise heavy concentrate mixture. When prices for these by-products are below the price of bran, they can be used in small amounts to cheapen the cost of the ration.

Commercial Protein and Mineral Supplements

During the past few years there has been a considerable increase in the sale of commercial mixed feeds in the western provinces. These feeds usually contain a variety of feed by-products that are often unavailable to dairymen in small quantities. Because coarse grains are readily available on most farms, dairymen prefer to purchase protein and mineral supplement mixtures that can be mixed with a prescribed quantity of ground coarse grains.

The value of such protein and mineral supplements to the dairymen is dependent largely upon the amount and kind of protein and mineral supplements they contain. Supplements with the higher protein content are worth more than those with less protein because more of the coarse grains can be added to obtain the desired mixture for feeding the herd. A comparison of costs between a home-mixed concentrate and one using a commercial protein and mineral supplement as prescribed by the manufacturer could be made by comparing the cost of a 1,000 lb. mixture in Table II with a 1,000 lb. mixture using the commercial feed.

When alfalfa hay is available there is less need for the protein and mineral supplements, and it may be to the advantage of dairymen to make their own concentrate mixtures if the required feeds are available.

All commercial feeds are sold under Dominion Feeding Stuffs Act which requires all sacks of commercial feed to show a guaranteed analysis and a list of the ingredients.

Minerals for Dairy Cattle

During the past decade considerable scientific information has been secured on the mineral requirements of dairy cows. In addition, numerous experiments have been conducted to determine the practical advantages of feeding mineral supplements. Commercial feed companies are offering for sale numerous kinds of mineral supplements that vary widely in suitability and price. There are a few that contain certain minerals that are not likely to be deficient in rations for dairy cattle.

A good dairy cow requires relatively large quantities of minerals to satisfy the combined needs for milk production, growth, reproduction and maintenance. When rations containing a fair variety of feeds are fed, there are only four minerals that are likely to be deficient, i.e. common salt, iodine, calcium (lime), and phosphorus. There is very little possibility of other minerals being lacking except under very unusual feed conditions.

Common salt (sodium chloride).—The feeds commonly used in dairy rations do not contain salt, and for this reason it has to be fed to all animals. It is a mineral that can be self-fed without danger of overfeeding, but certain cows occasionally may not eat sufficient to take care of their requirements. It is, therefore, a good practice to add 1 lb. of salt to each 100 lb. of the concentrate mixture. This insures that the heavy producing cows with the highest salt requirement will consume the most salt. Even when salt is fed with grain at this rate, additional amounts should be made available by allowing the cattle access to either a box of loose salt or to block salt.

Iodine may also be lacking in dairy rations. Serious losses due to iodine deficiency have occurred among newborn animals in most parts of Alberta. In dairy cattle iodine deficiency is indicated generally by the birth of calves that show one or more of the following symptoms—soft and flabby, goitred (big neck) and partially hairless. In many cases the calf is born dead or dies within a few days of birth.

Iodine is usually supplied in the form of potassium iodide. A convenient method of feeding the iodide is to mix 3 oz. of stabilized potassium iodide with each 100 lb. of salt. This is a good salt mixture to use with the grain as suggested previously. Iodized block salt usually contains less iodine and is best used as a supplement to the iodized salt fed in the grain mixture. Formerly iodized salt blocks lost most of their iodine on storage, but recent improvements in method of manufacture make it less likely that the iodine will be lost.

Calcium (lime) is only lacking in certain kinds of rations and in cows producing the larger amounts of milk. The rations most likely to lack calcium are those containing no legume hay such as alfalfa or clover. The grass hays and especially the cereal hays are fairly low in calcium, and the cereal grains that comprise the major portion of our concentrate mixtures are very low in this mineral.

Cows producing small quantities of milk can secure enough calcium from non-leguminous rations to meet their requirements. Heavy producing cows require more calcium than that contained in the average non-leguminous rations. It is true that animals store calcium in their bones and can use a large proportion of it to carry them over short periods of calcium shortages. It is, however, not good practice to force cows to use their bone calcium, as serious consequences may follow if too much is taken from their bones.

The best practice is to make certain that cows get sufficient calcium in their rations. The cheapest and surest way is to feed legume hays, as these contain ample calcium for the needs of all cows even if legumes comprise only half the roughage allowance.

When legume hays are not fed, a dairyman has the choice of feeding slaked lime, limestone, bonemeal or mono-calcium phosphate. The best way to feed these calcium supplements is to add 1 or 2% to the grain mixture, the higher amount being used when cereal hays are fed as well as when the cows are producing most heavily. Additional amounts can be fed by placing a box in the barnyard containing either the calcium supplement alone or mixed with an equal amount of salt.

Phosphorus is very seldom lacking when cows are being fed suitable rations containing good quality hays and grain. Phosphorus is most likely to be lacking in the hays grown on phosphorus-deficient soils. While legume hays contain more phosphorus than other hays, they may not contain enough to provide the required amounts.

Grains, and especially wheat bran, are rich in phosphorus, and cows fed a few pounds or more daily of a good concentrate mixture will receive ample. Phosphorus deficiency will therefore only occur when the cattle are receiving almost their entire ration in the form of roughage. As this practice is not recommended there is little possibility of a phosphorus deficiency occurring. When there is likely to be a phosphorus deficiency, however, bonemeal or mono-calcium phosphate if fed as prescribed under the discussion of calcium will provide ample quantities of both minerals.

Commercial mineral mixtures usually contain large percentages of the minerals mentioned. The addition of other minerals less

likely to be deficient lowers the percentage of those needed and makes the mineral more expensive.

Vitamins for Dairy Cattle

Recent research has shown that dairy cattle usually do not suffer from vitamin deficiencies when good rations are fed. Deficiencies of one or two of the vitamins may occur in stock that are not properly fed. Some of the vitamins are of special interest because they occur in milk and are important in human nutrition. A few of the more important vitamins will be discussed in relation to normal nutrition or milk composition.

Vitamin A, although essential for growth, health and reproduction, is especially important in preventing infections of the mucous membranes of the respiratory and digestive systems. Carotene, a color pigment found in the green leaves of plants, is the original source of vitamin A in animals. Vitamin A is colorless. When cows are on green pasture, their milk is richer in color and higher in vitamin A than when fed on the usual winter rations of hay and grain.

Since carotene and vitamin A are destroyed by oxidation, freshly cut hay when exposed to the sun and rain loses part of its vitamin A potency. It is also true that hay stored in the mow may lose most of its vitamin A before spring. Dairy cows fed old, colorless hay for prolonged periods may develop symptoms of a vitamin A deficiency. The lack of this vitamin may result in diarrhea and slow growth in calves and in the case of cows, lowered fertility and birth of weak calves. Inflammation of the eyelids, sore, watery eyes, sensitivity to light and blindness are other symptoms of a vitamin A deficiency.

Vitamin B, originally considered to be a single vitamin is now known to consist of at least three separate vitamins, namely thiamin, riboflavin and nicotinic acid. While these are known to be important for other classes of animals, they are not important for dairy cattle. It may be mentioned, however, that nicotinic acid has been used to control scours in newborn calves.

Vitamin C (ascorbic acid) prevents scurvy in man. It is not important in the feeding of farm animals because it has been shown that they are able to build up ascorbic acid from other substances in their feed. Some recent experiments have proven that the injection of ascorbic acid has improved the activity and fertility of certain slow breeding and low fertility bulls, and has also increased the fertility of cows.

Vitamin D is known as the "sunshine" or anti-rachitic vitamin. It is this vitamin that enables animals to utilize calcium and phosphorus. The need for vitamin D is high during periods of growth

and it is therefore important in the feeding of calves to prevent the development of rickets. It is also important during pregnancy for the normal bone development in the unborn calf, and during lactation because milk contains relatively large amounts of calcium and phosphorus.

Growing plants contain little or no vitamin D, but do contain a substance known as ergosterol, which is changed to vitamin D by exposure to sunlight or ultra violet light rays. Therefore only hays that have been exposed to sunshine can be regarded as good sources of vitamin D. Grains, roots and tubers contain no vitamin D. Dairy cattle usually receive their vitamin D from sun-cured hay as well as by their exposure to sunshine. Summer sunshine is more effective than that of the winter months in changing certain sterols in the animal tissues to vitamin D.

Milk varies in its vitamin D content according to the amounts of vitamin D in the ration and in accordance with the extent of the animal's exposure to sunshine. Summer milk contains more vitamin D than winter milk. Considerable interest has been shown in the production of milk that is rich in vitamin D. Feeding cows cod liver oil or other fish oils rich in vitamin D has been tried, but has resulted in a decrease in fat production and other undesirable effects. The feeding of irradiated yeast to cows has resulted in a considerable increase in the vitamin D content of milk. Irradiating milk with ultra violet light and by adding a vitamin-rich concentrate directly to the milk are the usual methods employed in producing milk rich in vitamin D. These practices are, however, only justified when a special demand develops or when special marketing arrangements can be made.

Vitamin E is the vitamin associated with reproduction. All natural feeds contain this vitamin, and it is especially rich in the germ of seeds. There is little possibility of sterility in dairy cattle arising as a result of vitamin E deficiency when they are receiving a ration of reasonable variety and quality. While the feeding of wheat germ oil rich in vitamin E for improving the fertility of cows and bulls has met with some degree of success, the improvement may possibly have been derived from constituents other than vitamin E.

Certain other vitamins have been isolated but it has not yet been shown that they are important in the feeding of dairy cattle.

Water Requirements

The amount of water required by cows is influenced by their size, milk production, kind and amount of feed fed, as well as by the temperature of the air. The results of experiments conducted at the University of Alberta show that dairy cows consumed between

3½ to 4½ gallons of water for each gallon of milk produced. Amounts up to 20 gallons of water daily were consumed by the heaviest producing cows.

Cows will consume more water if allowed free access to it at all times than if allowed water only once or twice daily. Then too, they will consume more water when it is not too cold and when they are not exposed to extremely cold temperatures or unfavorable weather. In connection with the University of Alberta experiments already mentioned, when cows had access to water at all times they consumed almost 8% more water and produced about 6% more milk than cows watered twice daily. While a watering system in the barn is much better than outdoor watering, it is not essential to have individual water bowls for the cows if some other system can be devised to allow cows access to water more often than twice daily.

Cows will drink more water after eating grain and hay than at any other time. The feeding of ensilage or other succulent feed is beneficial mainly because they contain large amounts of water and not because they possess any special nutritive value. If water is not available in the barn, the outdoor water troughs should be sheltered from prevailing winds and a water heater used to raise the temperature of the water high enough to enable cows to consume a maximum quantity.

Summer Feeding

Pasture is the ideal feed.

Pasture is the natural feed of cattle. As has been mentioned already, it furnishes an ideal feed for the dairy cow at a lower price than any other feed. Pasture grasses supply nutrients of the right kind for growth, pregnancy and milk production. The immature grasses are more palatable, and they contain more protein, minerals and vitamins than the same plants when more mature.

Pasture provides the cheapest feed.

Pasture yields vary according to the type of soil and kind of plants grown, as well as upon moisture and temperature conditions during the growing season. The tonnage yield of pasture is greater and more nutritious than the hay crop, and an acre of pasture will produce more milk and butterfat than the same crop cut and fed as hay. In addition, the cow will do a much more economical job of harvesting than when the crop is cut and stored as hay.

Pasture alone is insufficient for high producing cows.

When cows are on good pasture, they can consume enough grass to maintain themselves and produce about ¾ lb. of butterfat

daily. This means that in the case of cows producing not more than 20 lb. to 25 lb. of milk, good pasture will take care of their requirements. Supplementary concentrate mixtures are necessary to meet the needs of cows producing more than these amounts. The cows will not only maintain production at higher levels during the pasture season, but will maintain that higher level after the pasture season has ended.

Feeding concentrates to cows on pasture is a profitable practice when prices are normal in relation to the price received for milk or butterfat. When feed prices are relatively high or the prices of dairy products are relatively low, the profitability of grain feeding becomes less. The amounts of grain to feed cows on pasture are shown in Table IIIb, page 30.

The concentrate mixture fed to cows on pasture can be carbonaceous, consisting only of ground oats or barley, because the pasture grass consumed will provide the necessary protein as well as minerals.

Milk production during the fall can be maintained.

During the latter part of the summer and early fall the growth of pasture is retarded and fails to provide as much feed as during the late spring and early summer. As the pasture growth declines, it becomes difficult or impossible for the cows to obtain sufficient pasture for a good fill. Milk production will decrease under these conditions unless extra feed is provided to offset the pasture shortage. This extra feed can be provided either in the form of freshly cut hay crops, silage, increased grain allowance, or by providing additional pasture.

Providing ample pasture is profitable.

Because pastures provide the cheapest source of food, ample pasture should always be provided. On most dairy farms native pasture on land unsuited for cultivation is insufficient to meet the needs of the dairy herd, and cultivated pasture crops must be seeded. Crops suitable for pasture vary in yield as well as the length of growing season. Less pasture land is required when the heavier yielding and longer growing pasture crops are grown.

Perennial grass pasture crops.

Most grass crops that make suitable pastures can also be cut for hay. Such grasses as timothy, brome, slender wheatgrass (western rye), creeping red fescue, red top, crested wheat, Kentucky blue and reed canary grass can be used alone or in mixed pasture under conditions most suitable for their growth.

The soil and rainfall conditions most favorable for their growth have already been discussed individually under the subject of hays. In general, grass crops provide less forage and for a shorter period than the legume or mixed legume-grass pastures.

Legume pastures.

These yield more forage, and can be pastured for a longer period than the annual or perennial grass pastures, but the danger from bloat is greater. These crops are usually cut for hay for one or more years before being used as pasture in most good rotational crop plans.

Alfalfa is both highly palatable and nutritive, but cattle pastured on this crop are more subject to bloat than on any other single pasture crop. The danger from bloat can be lessened in several ways: (1) by turning cows on the alfalfa pasture after they have eaten a feed of hay, or (2) after they have just previously been foraging on a grass field, (3) by not turning cows on alfalfa pasture which is moist with dew, nor (4) on to pasture of recent seeding. It is best to pasture on an older crop that has been cut for hay for two or more years. (5) by growing an alfalfa-grass pasture mixture. Alfalfa can be pastured much more safely when it comprises only part of the pasture mixture. The grass content of these mixtures greatly reduces the danger of bloat.

Sweet clover pasture may not be as palatable as alfalfa until cows have become accustomed to it. It may cause bloat during the first year of growth, but rarely causes bloat the second year unless early in the spring when making the most vigorous growth. It is a difficult crop to pasture evenly, and portions of the field usually grow rank and coarse. On irrigated pasture this can be controlled by proper irrigation.

Red clover (altaswede) pasture is very suitable for a dairy pasture. There is not as much danger of bloat as in the case of alfalfa, but the same precautions against bloat should be taken. Red clover is best used in a legume-grass pasture mixture.

Pasture mixtures are the best.

They furnish more forage than the single crop pastures and provide a longer pasture season. Mixed pastures should contain both legume and grass plants most suited to the soil condition as discussed previously under the individual hays. (See pages 31 to 34.) Some pasture mixtures make excellent hay crops, and the practice of utilizing the crop for hay for a year or more after seeding before using it for pasture has proven to be satisfactory for a rotational scheme. The heavier yields of these mixed pastures

reduce the land required for pasture and allow more land to be used for other crops.

Suggested Pasture and Hay Mixtures

In the black soil areas where rainfall is fairly good, the following seeding mixture per acre is suggested:

Alfalfa	4 lb.
Altaswede Clover	3 "
Brome	2 "
Kentucky Blue Grass	2 "

In the gray soil areas with similarly good rainfall the above mixture could be altered by substituting white dutch or alsike clover for the altaswede clover.

For the drier districts of the province, crested wheat grass is the chief pasture crop and can be seeded alone at the rate of not more than 8 pounds. If experience has shown that other crops such as sweet clover, alfalfa or brome will make a reasonably good growth, small amounts can be substituted for part of the crested wheat.

In areas of intermediate rainfall the mixture should contain at least one legume, and a drought resistant grass that is adaptable to local soil conditions.

It is also suggested that the pasture mixture used be such as can be used as a hay crop for one or two years after seeding before being used as pasture.

Supplementary Pasture Crops

Before the main dairy pasture can be used in the spring and after it ceases to provide ample forage in the fall, cows must be either barn fed or placed upon a supplementary pasture. The seeding of special crops has proven the cheaper and most satisfactory method of feeding the herd during these periods.

Oat pasture can be seeded early or late to provide either the main pasture or late supplementary pasture. When used as the main pasture it does not provide as early a pasture as do the perennial grasses. Oat pasture has a fair carrying capacity, but does not have a long growing season. For a supplementary pasture oats can be seeded at the rate of $2\frac{3}{4}$ bushels per acre late in July on well prepared land, and under suitable conditions will provide four to six weeks of pasture after the regular pasture has been finished.

Fall rye is the earliest spring crop, but only supplies pasture for a short period. In the spring it is only used until the other pastures are ready, and then plowed up and re-seeded the same

year to a late sown crop. However, it also can be used in the previous fall if precaution is taken not to overgraze.

Rape pasture is not desirable forage for the milking herd. It may, however, be used satisfactorily for young stock and dry cows. There is, however, some tendency to bloat when cattle are pastured on wet rape. It is quite laxative and therefore is usually not fed as the sole pasture. Milk from cows on rape pasture has a disagreeable flavor. For these reasons rape is not recommended as a suitable pasture.

Feed and Care of Cow at Calving Time

Calving time is a critical period in the life of a cow, and her feeding and care during this period have a great deal to do with her subsequent milk production. At parturition her whole system changes from that of pregnancy to lactation. Before a cow calves, the feed she eats is used to nourish the embryo and to build up her own tissues in preparation for the coming lactation period. No milk is being produced and her nutrient needs are therefore mostly carbonaceous and relatively small. But after calving she begins to secrete large quantities of milk which necessitates large quantities of protein and minerals. Failure to provide these nutrients results in a depletion of the cow's body reserves followed by a reduction in milk flow.

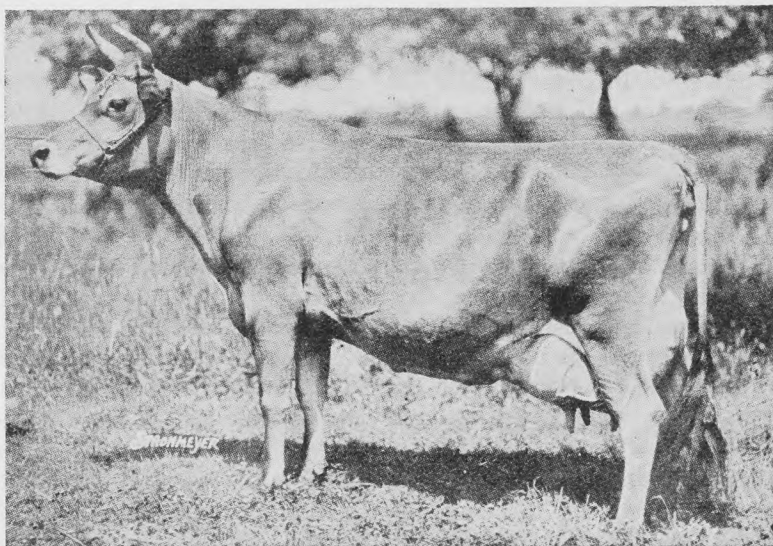


Fig. 7—The world's highest producing Jersey, Brampton Basilua, imported and owned by B. H. Bull & Sons, Brampton, Ontario, with 5-year-old record of 19,012 pounds of milk and 1,313 pounds of butterfat.

A great deal can be done to aid the cow in making this drastic change in function. She should receive invigorating feeds prior to calving to assist her during parturition. There should be a reduction in the amount of concentrate fed so as to avoid digestive disorders and to stop the tendency to put on flesh. She should be offered warm water often to meet her increased water requirement. For a day or two prior to calving it is good practice to feed warm bran mashes of 3 or 4 lb. twice daily and to allow her to consume the usual amount of good quality hay.

Following calving, warm bran mashes should be continued for about two days to help stimulate milk production and aid in the expulsion of the afterbirth. If the udder continues to be inflamed and "caked", the bran mashes should be continued for a longer period. After the udder reaches nearly normal, the bran should be gradually replaced by small amounts of the herd concentrate mixture. Cows should not be fed a full grain allowance until three weeks or longer after calving if the udder continues to be inflamed.

When udders become seriously inflamed and congested before calving some relief can be given by milking regularly and completely prior to calving. The only problem arising from milking cows before calving is that there may be no colostrum for the calf. This can be offset by either freezing the milk obtained before calving for later use, or by adding vitamin A to the milk produced after calving. Some Jersey breeders claim that the premilking of heifers reduces the danger of udder damage caused by excessive inflammation.

Cows that are to calve should be placed in a clean box stall and allowed to care for their calves as soon as they are dropped. Cleanliness at this time is important for the health of the calf, and as a means of protecting the herd in case there has been an abortion. In the latter case the dead calf and afterbirth should be carefully removed and burned, and the box stall again disinfected.

A mature cow in good condition will usually expel her calf without any assistance. However, some assistance may be necessary for young heifers and for cows that are weak, overly fat, or that fail to develop normally in their pelvic area. When the calf is being presented in an abnormal position it is often possible to manipulate it into normal position to facilitate expulsion.

The cow should not be completely milked out for two or three days as there may be some danger of milk fever developing in a high producing cow. Leaving the calf with the cow during the first few days helps to remove congestion in the udder. The cow should be milked to prevent too much accumulation of milk in the udder, but not all of the milk should be removed until the udder is well on the way to becoming normal.

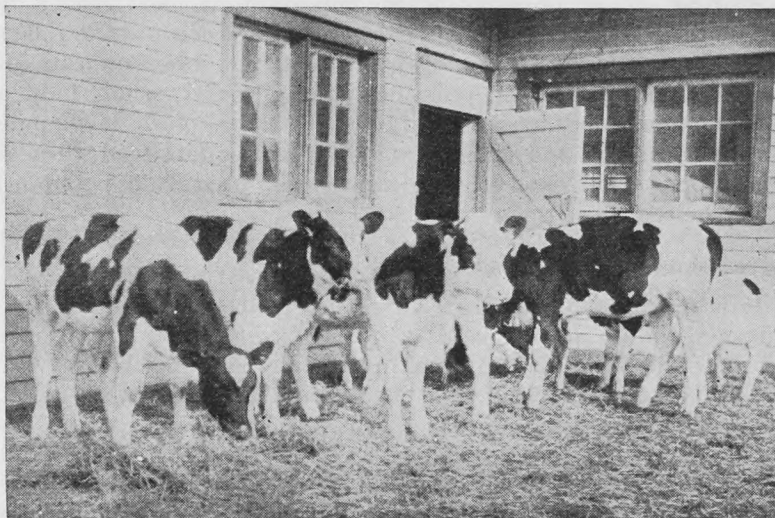


Fig. 8—Calves of today are the milking cows of tomorrow.

If the calf is taken from the cow soon after it is born, the cow has to be milked several times daily to obtain the colostrum milk so necessary for the well-being of the new born calf. If the udder is congested, it should be massaged, given heat applications or otherwise treated to remove the inflammation. Some dairymen believe that when the calf is taken from the cow soon after birth it is easier to train the cow for the normal milking procedure and to teach the calf to drink from a pail.

It is important to treat cows with kindness during parturition. Cows handled quietly and gently will allow the attendant to give any necessary assistance during parturition and can be quickly induced to let down their milk and be milked.

Raising the Calf

In average herds approximately one-quarter of the cow herd has to be replaced annually. The heifers retained must be as good or better than the cows if the herd production is to be maintained or increased. If the herd sire has been well chosen, the calves born in the herd should be an improvement on their dams. While replacements can often be purchased at low prices there is some speculation as to their milk producing ability, freedom from disease, or abnormal hereditary traits. Raising heifers calves out of the best cows in the herd and sired by a good purebred bull is the surest way to obtain satisfactory replacements.

Raising calves properly is as important as the feeding and care of the milking herd. The calves of today become the milking cows of tomorrow. Calves are born with an inherent milk producing possibility, which only becomes a reality when they are reared under conditions most favorable to the full development of all parts of the body. Stunting from inadequate feed, ill-health or improper care reduces the future milk producing possibilities of the heifer.

Calves should get the right start.

It is most important that calves get well started in life. The dairymen should make sure that the calf begins to breathe properly as soon as it is dropped by making certain that the fetal covering is not over the nostrils. The cow should be allowed to lick the calf dry. Tincture of iodine should be applied to the navel as soon as the calf is born to prevent infection. If the calf has not suckled within a few hours, assistance should be given to make sure the calf receives the colostrum milk. This milk is essential to stimulate the digestive tract. It acts as a laxative and contains vitamins and minerals necessary for growth and prevents calfhooch infections and diseases. In case the mother dies, the addition of vitamin A to normal milk has been found to be a fair substitute for the colostrum milk. If the cow's milk is too rich in fat, it may result in scours. In such cases the calf should be taken from the cow and fed a limited amount of the same milk diluted with water.

The first three weeks.

The calf should always be fed its own mother's milk until three weeks of age. Extreme patience should be exercised in teaching a calf to drink milk from a pail. Quite often calves will drink too rapidly and develop digestive ailments. Nippled pails or other devices can be used to induce the calf to drink slowly. It is only necessary to feed a pound of milk daily for every ten pounds of live weight. Small Jersey calves require six or seven pounds, while a one hundred pound Holstein calf would require ten pounds of milk daily. Scours are sometimes caused by the calves drinking too much milk that is too rich. The milk allowance should not be increased above the amounts mentioned above, and at no time is it necessary to feed more than twelve pounds daily. It is essential that the milk pail be thoroughly washed after each feeding, as disease bacteria multiply very rapidly in dirty utensils.

Calves will begin to nibble at grain when they are ten to fourteen days old. Small handfuls of coarsely ground oats can then be thrown into the empty milk pail as soon as the milk has been drunk. After the calf has learned to eat grain, it can be self fed with-

out danger of over-feeding for several months. Up to three weeks of age calves will eat very little hay, but it is a good practice to allow them to eat as much hay of good quality as they desire.

Three weeks to four months of age.

This should be the period of skimmilk feeding. If skimmilk is not available, whole milk feeding should be continued. The change from whole milk feeding to skimmilk feeding should be gradual and take approximately a week's time, as any sudden change in feeding will cause digestive ailments. The feeding is very important during this period because considerable amounts of protein and minerals are still required. However, there is no advantage in feeding large quantities of skimmilk, 12 lb. daily being usually sufficient to supplement the hay and grain part of the ration.

A satisfactory concentrate for calves of this age can be ground oats alone or a mixture of equal parts oats and barley. It may be self fed until 3 lb. of grain is being consumed daily without danger of over-feeding. Calves, however, will not require more than 3 lb. of concentrates while receiving skimmilk. The feeding of good quality hay should be continued and calves should be allowed to eat as much as they desire. The consumption of hay should be encouraged to aid in the development of a good digestive system.

In the summer calves of this age cannot consume enough grass to equal hay and grain feeding. It is best to place the calves in a small grass paddock. Skimmilk and grain should always be fed while the calves are on pasture, and they should have access to some hay.

Water should also be provided, as the skimmilk fed does not satisfy the water requirement. This fact is sometimes forgotten when calves are young and kept in the barn.

Four months to one year of age.

During this period there is continued rapid growth and the nutrient requirement is fairly high. Skimmilk feeding may be discontinued at four months of age if good quality hay and a suitable concentrate mixture are fed. Protein and minerals should be added to the grain mixture to partially replace those that had been supplied in the skimmilk. If only grass hays are available the concentrate mixture with 20% wheat bran or 10% linseed meal would be more suitable than grain alone. The concentrate mixture should also contain 2% of bonemeal. The amount of concentrates mixture to feed daily depends upon the condition of the calf. Between two and four pounds of concentrates are usually required to keep the calf in fair condition and growing vigorously.

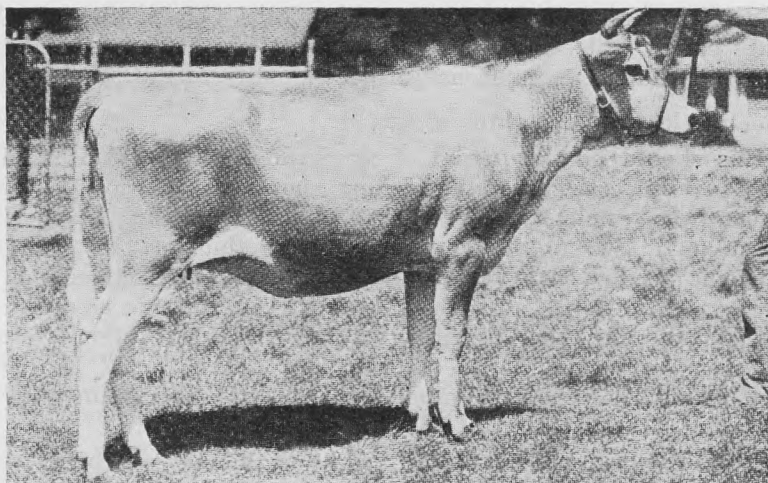


Fig. 9—Only heifers well raised become profitable cows.

There is no advantage in feeding dairy calves so that they carry excess flesh. Heifers should be fed so they develop the ability to consume large roughage allowances rather than the more expensive concentrate mixtures.

The hay fed should be of good quality to help replace some vitamins and minerals that had been supplied in the skim milk. It is of particular importance that the hay be green as a deficiency of vitamin A may develop. Alfalfa hay is ideal for young heifers. It contains sufficient protein, minerals and vitamins to make it unnecessary to add protein rich supplements or minerals to the grain mixture.

Pasture grass is also ideal, but will not provide ample nutrients to meet all requirements. Grain feeding must be continued while the calves are on pasture, but the addition of protein rich supplements and minerals to the grain mixture is unnecessary.

Yearling heifers.

Year-old heifers are usually not difficult to feed as their protein and mineral requirement has become less. Usually these heifers can make normal growth on legume hay of good quality with a very limited amount of grain. The heavy feeding of roughage with limited grain feeding helps to develop a good framework and large barrel, a necessity for high production. Since good quality hay or luxurious pastures may not always be available, the feeding of suitable grain and supplements is often necessary. The amounts of these feeds fed should be based upon the condition of flesh and general thrift.

Milk Substitutes and Calf Meals

On farms where whole milk is sold it is impractical to provide skim milk for calf feeding and it is expensive to continue liberal whole milk feeding till four or six months of age. Some saving can be made by slightly reducing the whole milk allowance below the amount previously mentioned, or by feeding skim milk substitutes, calf meals or gruels. The feeding of inadequate quantities of milk during the first few weeks or eliminating milk before the calf is able to consume and digest substitute feeds results in the permanent stunting of calves and unthriftiness. Fresh whole or skimmed milk contains nutrients that are ideal for young calves, and as yet a perfect substitute has not been discovered.

There are several ways of successfully raising calves on farms where whole milk is sold. First, by feeding minimum amounts of whole milk properly supplemented with a suitable concentrate mixture and hay. Second, by feeding a so-called "milk substitute", calf meal or gruel.

Numerous experiments have been conducted to determine how early calves can be weaned and how much the daily allowance of skim milk can be reduced without affecting the growth and thrift of the calves. The answer to these questions was found to be largely dependent upon the suitability of the concentrate mixture and hay fed. In experiments conducted at the University of Alberta it was found that calves could be weaned at four months of age when receiving the following concentrate mixture with a good quality grass hay and not more than 12 pounds of skim milk daily:

Oats	38 lb.
Barley	30 lb.
Wheat Bran	30 lb.
Salt	2 lb.

From the results of other experiments it was concluded that the more complete a concentrate mixture is in the nutrients required by the calves, the less milk will be required and the sooner calves can be weaned. The following concentrate mixture proved slightly more satisfactory in feeding calves on limited amounts of milk than the ration previously mentioned:

35 lb. oats
28 lb. barley
12 lb. wheat bran
10 lb. red dog flour
6 lb. linseed meal
5 lb. blood flour
2 lb. bone flour
2 lb. salt

100 lb.

Dairy calves can be satisfactorily raised on commercially prepared feeds. Since all contain some skim milk or buttermilk powder

they can be used to replace some or all of the fresh whole or skim-milk usually fed.

The results of recent experiments conducted elsewhere to find an economical milk substitute feed for very young calves have been encouraging. A few manufacturers are now preparing feeds suitable for calves three and four days of age when the colostrum ceases to be produced. These milk substitutes contain skimmilk powder, fats, molasses, minerals, vitamins and antibiotics. Such feeds are fed in liquid form to replace the milk usually fed to calves.

The commercial calf meals that have been on the market for a number of years are most suitable for calves after three weeks of age. They contain some skimmilk or buttermilk powder plus ground grains, by-product feeds and minerals. The following mixtures are suggested and represent approximately the ingredients of commercial calf meals:

30 lb. oats
30 lb. barley
20 lb. skimmilk powder
8 lb. wheat bran
8 lb. linseed meal
2 lb. bone flour
2 lb. salt
<hr/> 100 lb.

30 lb. oats
20 lb. skimmilk powder
20 lb. wheat middlings
15 lb. hulled oats
7 lb. blood flour
5 lb. linseed meal
1 lb. salt
2 lb. bone flour
<hr/> 100 lb.

A good calf meal should contain about 25% crude protein, 3½% fat and not more than 4% fiber.

The meal is usually mixed with six or eight parts of water and fed in the same quantities as skimmed or whole milk. The calf meal or gruel does not replace the hay and grain usually fed to skimmilk calves. The following table summarizes the suggestions presented in feeding calves:

	Whole or Skimmed milk With dam	Calf Meal Gruel	Hay and Grain
1- 3 days	8-12 lb.		
3- 21 days	9 lb.	3 lb.	Same as
21- 28 days	7 lb.	5 lb.	for
28- 35 days	5 lb.	7 lb.	skimmilk
35- 50 days		12 lb.	calves
50-120 days			

Exercise is essential for calves of all ages.

During the winter calves should be allowed the freedom of a small pen in a part of the barn that is well lighted. When the weather is not too severe they should be outdoors in a pen or yard protected from prevailing winds. The outdoors sunshine prevents the development of rickets and aids normal bone growth and development. In the summer the calves should be kept in a grass paddock with some shelter from the hot sun and inclement weather.

Dehorning

Horns on dairy cattle make their handling more difficult and are a source of danger to other cattle and to the dairyman.

The use of a caustic potash to remove horns of calves when one or two weeks of age is a more satisfactory method than removing horns of older cattle by sawing or clipping. The caustic potash method is also more easily accomplished and causes the least discomfort to the animal.

Procedure: remove the hair surrounding the horn button with shears or clippers. Rub moist stick of caustic potash over and around the horn button until the skin ruptures and begins to bleed slightly. When excessive amounts of potash are used, some may run down the face and endanger the eyes. To prevent the spread of potash a ring of vaseline can be applied to the area immediately surrounding the horn button, and the calf isolated from the others and protected from rains.

For dehorning older cattle, dehorning clippers or saws are used. The use of clippers is best for younger animals whose horns are not too heavy or brittle. The horns should be removed as close to the skull as possible to prevent further growth. After bleeding has ceased, disinfectants should be applied that will prevent infection and repel flies. Pine tar is recommended as it will stick to the wound for several days and is a good fly repellent.

Feed and Care of the Dairy Bull

The feeding of the dairy bull is relatively simple, but some thought should be given to the kinds and amounts of feed required to maintain his breeding efficiency. He should be fed as much hay as he will eat without undue waste. The amount of grain to be fed will depend upon his condition of flesh and amount of service. It is desirable to maintain a bull in a thrifty condition by feeding suitable feeds in sufficient quantities. At no time should bulls be allowed to become excessively fat or thin.

The care and management of the dairy bull is of extreme importance because improper care and management may lead to viciousness and impotency. The management of a herd bull is usually not difficult if he is properly handled when young. A ring should be put through the nose before he is a year old and be changed for stronger ones as he gets older. A strong bull staff should always be used in leading a bull. An additional safety device is a six or seven foot chain with one end looped around the horns and the other end passing through the nose ring, the end being allowed to drag.

Keep the bull in separate quarters.

The bull should not be allowed to run with the herd, as bulls managed in this way tend to become vicious. The bull should be

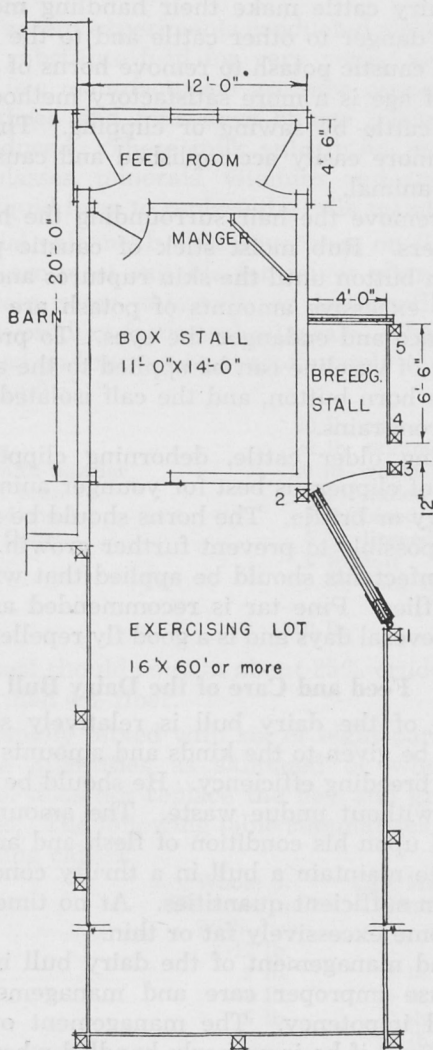


Fig. 10—Floor plan of a bull shed, exercising yard, and breeding stall.

The floor plan shows the desired location of the posts numbered in the order in which they should be situated. The stall is 6'6" long from post 4 to post 5 and 4' wide. Post 4 is situated 12" from post 3 so the attendant may facilitate service if necessary. The width of the gate from post 1 to post 2 may vary from 6' to 8'. The stanchion at the end of the stall is built in a swinging gate which opens to the outside so the cow may be let out.

—Courtesy Illinois Agr. Exp. Sta.

housed in a separate shed or given a suitable box stall. Outside the shed or box stall there should be an exercising pen and yard where cows can be bred. This arrangement avoids the risk of injury to the attendant. A small grass paddock just outside the exercising pen is excellent for providing succulent forage during the pasture season. The fences holding the bull should be strongly built. The additional use of a single electric fence wire strung inside the bull exercising pen and paddock prolongs the life of the fence and aids in keeping the bull under control.

Exercising the bull is important.

Bulls require plenty of exercise if they are to be kept in a vigorous condition. Various methods have been devised to induce bulls to exercise. An empty barrel or keg on the ground in the bull pen, or a heavy block of wood hung between two posts provides something for the bull to exercise on. When an exercising pen is not available, bulls can be tied to a ring which slides on a cable. Usually these cables are about 100 ft. long and strongly constructed. The lead chain should be attached to the bull ring and be of a length which does not allow the bull to step over.

Service.

The young bull can be used for light service when ten to twelve months of age. Mature bulls can serve three or four cows weekly. Usually one bull if kept in good condition can be used on 80 to 100 cows annually if they are bred to freshen uniformly throughout the year. Over worked bulls become inefficient breeders as the number and vitality of the sperm cells become greatly reduced. Only one service should be given to each cow when the bull is being used regularly. If however, the bull has been idle for ten days or longer, cows should be given two services because the semen in the first service may contain a high proportion of dead sperms cells.

"Safety First" should be practiced by dairymen in all dealings with dairy bulls. Regardless of how quiet and harmless a bull may appear, experience has proven that no bull can be trusted at all times. In feeding and handling any bull the dairyman should always be on the alert and take no unnecessary chances.

Cost of Producing Milk

The main purpose of determining the cost of milk on any farm is to find out how efficiently milk is being produced. This is done by comparing the individual cost items of one farm with those of another. By such comparisons the most efficient practices can be determined and applied on the farms showing the higher costs.

Milk costs are usually calculated on a yearly basis. On calculating the cost of producing milk, the following charges are made:

1. Feed costs.
2. Labor costs.
3. Building and equipment costs.
4. Depreciation and interest on herd values.
5. Miscellaneous charges.

Feed cost comprises from 40% to 50% of the total cost of producing milk. It will vary from year to year according to fluctuations in feed prices. The fact that feed accounts for such a large proportion of the cost makes possible wide variations in costs between farms using different feeding practices. Feed costs are low (1) when the less expensive feeds are fed, (2) when the cows are not overfed, (3) when cows are not underfed to seriously affect milk production, and (4) when balanced rations are fed.

Labor costs also vary greatly and range between 30% and 40% of the total cost. Differences in wages, in the estimated value of family help, and what the owner considers his work is worth determine most of the differences in labor costs between farms. The cost of hauling milk from farm to market is sometimes included under this item. Differences in the efficient use of labor as shown by differences in hours of labor required to produce 100 lb. of milk may be caused by differences in equipment used and in the arrangement of the barn.

Building and equipment costs vary from 5% to 15% of total costs, and largely depend upon the value of the dairy barn and milk house as well as equipment. The farmer should charge a reasonable interest on his dairy barn and equipment investment and also should charge depreciation on same. Those dairymen who build unduly expensive barns and buy expensive equipment will have much higher cost for this item than dairymen using less expensive barns and equipment.

Cow charge includes the interest on the investment plus depreciation. This charge usually is only 6% to 8% of the total cost. Cows only average from four to five years' production in a dairy herd, which makes the depreciation charge rather high. This may appear to be a short time, but when it is realized that disease, injuries, sterility and other ailments take a heavy toll, this charge is not too high.

Bull charge is only 3% to 6% of the total cost. It varies likewise according to the value of the animal, and whether or not the bull will have a higher or lower value when sold. The bull charge for each 100 lb. of milk is necessarily high in small

herds because the item will be the same in a ten cow herd as in a 50 cow herd.

Miscellaneous charges may amount to 20% or 30% depending upon the number of items included, and upon the expense of each. These items include cow testing fees, medical and veterinary fees, dairy magazines, disinfectants, breed association fees, etc.

Production per cow is the greatest factor.

Production can greatly affect the cost of producing milk because the cost items increase at a slower rate than milk production. Thus, as production increases, the cost of producing 100 lb. of milk or a pound of butterfat decreases. Dairymen with high producing herds have a lower cost of production than dairymen with low average herds. All dairymen should strive to reduce the costs of producing 100 lb. of milk or 1 lb. of fat by increasing the average production of their herds.

Increasing production per cow can be attained by (1) using better bulls, (2) culling out low producers, (3) feeding more suitable rations, (4) providing adequate all-season pasture, (5) controlling diseases, and (6) breeding for more early winter freshenings.

Increases in production resulting from improved methods of management are accomplished with little or no increase in cost, thus producing a greater net income.



Fig. 11—A profitable cow, University Rosebud Pontiac 124830, bred and owned by the University of Alberta. A 20-year-old cow that produced 14 calves and has official records totalling over 180,000 pounds of milk, 7,000 pounds of butterfat.

Increasing labor efficiency.

The labor required to produce each 100 lb. of milk is reduced as the size of the herd increases. This is especially true when small herds are increased to 10 to 12 head, a size considered most suitable for a one-man dairy farm. Providing pastures nearer to the barn, improving barn procedure in feeding and milking, and installing labor-saving devices or equipment are other methods of reducing labor costs.

Combining Other Farm Enterprises with Dairying.

Dairymen should be interested in making the greatest total profit from all of the enterprises on the farm rather than from dairying alone. As a general rule on every farm there are certain combinations which will yield greater total net profits than any one enterprise alone. The combination of enterprises established on the farm is likely to be influenced by the aptitudes of the farmer and also by crop yields and certain economic conditions. In creamery areas the net earnings usually can be increased by keeping hogs or poultry since these make the most efficient use of the skim milk available. In areas where whole milk is sold, cash crops may prove the most profitable combination along with dairying.

Dairying is one of the most intensive of farm enterprises and involves many different kinds of work, each of which has to be efficiently done to make it profitable.

Milk Secretion and Milking Practices

A knowledge of how milk is secreted is of practical value because it suggests how milking can be most efficiently done. During recent years certain discoveries have been made that explain how and why certain things happen in the udder of milking cows. There is, however, still a great deal more to be learned about this complex process. From the knowledge already available, certain principles for milking cows have been established. By applying these principles the dairyman can get the most milk at each milking as well as throughout the lactation period.

The normal cow's udder consists of four mammary glands called "quarters". The amount of milk that is secreted depends upon the size and amount of glandular tissue in the udder. The udder contains innumerable connected ducts or openings of different sizes that hold the milk which has been secreted. The smallest of the openings are microscopic in size and are called *aveoli*. Each small opening is lined with special cells that take certain ingredients from the blood and reconstruct them into milk, which is then expelled into the microscopic openings.

Milk is secreted at all times.

While it was formerly believed that cows secreted milk only during milking time, it is now known that milk is secreted during the entire period between milkings. As proof of this cows have been slaughtered just prior to milking time, their udders have been removed and milked or analyzed for the milk contents. These studies have shown that all milk that would have been expected by milking was present in the udder. Milk secretion is most rapid just after milking, and slows down as the glands fill with milk. This accumulation of milk in the udder builds up a pressure which may even rise sufficiently to cause milk secretion to stop.

Milk completely and often to get the most milk.

These facts concerning the rate of milk secretion have a very important bearing on how cows should be milked. Firstly the cows should be completely milked out because any milk remaining in the udder would leave a pressure that would reduce the rate of milk secretion that follows. The same thing occurs when cows fail to "let down" their milk, because not all the milk in the udder can be obtained. Secondly, if cows are milked more frequently, more milk will be produced daily, because the pressure will not rise to the same levels and retard milk secretion to the same extent. Some experiments have shown more than 20% increase in milk production for three times a day milking as compared with twice a day milking, and more than 30% increase for four times a day milking can be obtained. The economy of milking more than twice daily is largely dependent upon the amount of milk the cows produce. Thirdly, the best way to dry off cows is to leave considerable milk in the udder to retard further milk secretion. Some authorities even advocate abruptly ceasing to milk cows in order to dry them most quickly. Fourthly, the effect of udder pressure explains why the inflation of the udder with air is effective in curing milk fever.

How cows "let down" their milk.

The milk in the aveoli and the smaller duct remains in the udder until it is squeezed out. The muscular contractions that occur at the time of milking explain how cows "let down" their milk. If these muscular contractions do not occur, not all the milk can be withdrawn, and it is said that the cows "hold up" their milk. Scientists have proven that a hormone secreted by the pituitary gland causes these muscular contractions that force the milk to be released in the udder. When milking first begins, the manipulation of the teat and the warmth of the hands causes the pituitary gland to secrete the hormone (oxytocin) into the blood

which, when it reaches the udder, causes the muscular contractions to occur. This results in a rapid rise in udder pressure which remains higher than normal for several minutes. If cows are milked during this higher pressure period all the milk can be obtained.

Other things may cause cows to let down their milk. The regularity of sounds or events that occur just prior to milking may become associated with the milking act and cause the secretion of the hormone responsible for the letdown. In addition, driving cows from pasture, bringing them into the barn, grain feeding, washing udders, the rattle of pails or the noise of the milking machine may all cause individual cows to let down their milk before milking is started. Such cows should be milked first to take advantage of the increased pressure present.

Rapid milking is recommended.

To get the most milk from cows, milking must be completed during the "letdown" period. Since this period lasts only a few minutes rapid milking is now recommended as the most efficient method. Milking machine companies have improved their machines to enable faster and more efficient milking. When cows are milked slowly most of the milk left in the udder after the extra pressure of the "letdown mechanism" is released cannot be obtained.

Cows can "hold up" their milk.

Cows that are frightened, or distracted from the usual events of milking or barn procedure, may not let down their milk. Allowing a dog to chase the cows, mistreatment, having a different person milk the cows, the presence of strangers in the barn or unusual noises during milking time are a few of the things that may cause sufficient disturbance to prevent the normal secretion of the hormone. Such cows will hold up part of their milk and this in turn acts to retard subsequent milk secretion. Regularity, quietness, kindness in handling the cows are factors which indirectly affect milk production.

Milking machines are not harmful when properly handled.

The latest models of milking machines if properly operated will maintain production at as high levels as the hand milking method and will have no harmful effect on the cow's udder. The proper operation of a milking machine includes maintenance of mechanical efficiency, the observance of sanitary standards, as well as avoiding harmful practices in the use of the machine on the cows. The cows should be encouraged to let down their milk just before the teat cups are applied to the teats. They should be removed as soon as the milk flow ceases. If machines are allowed to operate when milk has ceased flowing, the results may be injury to the

lining of the teat. For best results all milking machines should be operated according to the directions of the manufacturer.

Inheritance is involved in milk secretion.

Inheritance of milk production is made possible not only through transmitting udder size and quality to the next generation, but also by transmitting the ability to produce the essential hormones involved in the secretion of milk. Several hormones are necessary for the growth and complete development of the udder, the thyroid, pituitary and ovary, each secreting one or more hormones whose activity enables udder growth and development to take place. Hormones which can stimulate milk secretion during lactation and others that act to inhibit milk secretion during pregnancy are also secreted.

The secretion of milk is therefore a series of complex processes, each requiring special conditions for successful completion. Feeding, breeding, care and management are important factors which are directly or indirectly associated with milk secretion in determining in a large measure the extent to which milk production will approach the inherited capacity of the cow.

Cow Testing

When records are kept of the pounds of milk and butterfat produced by each cow, they furnish much valuable information. The keeping of these records enables a dairyman to determine which of his animals are proving the most profitable. Cows of low production due to short lactation periods or low test can be located

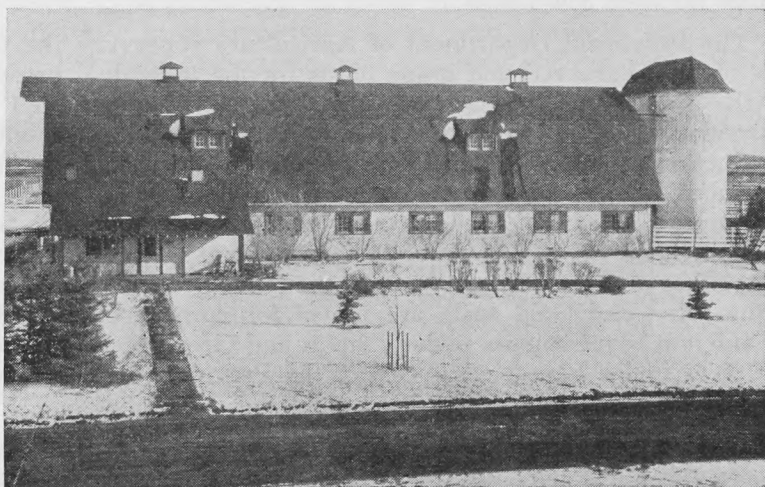


Fig. 12—Dairy barn, University of Alberta, Edmonton, Alta.

and culled from the herd. By the use of records, calves from the best producing cows can be retained.

The influence of feed changes can be noted and rations most efficiently utilized by herds can be formulated. The onset or severity of a disease or ailment can be often observed by a sudden drop in production, and remedies can be given before severe damage is done. When no records are kept none of these advantages are obtained, nor an increase in the profitableness of dairying secured with the same degree of certainty as when records are available.

It is more necessary for breeders of purebred dairy cattle to keep production records because the sale price of their bull calves and surplus females is largely dependent upon the production record of their dams. Purebred breeders must maintain the superiority of their purebred animals over grade stock by careful selection and the keeping of production records if fair prices are to be secured for their purebred sale stock.

The Canada Department of Agriculture through their Records of Performance service supervises the testing of all purebred cows. To obtain this service the breeder must place all registered cows on test as long as the herd is on test. Inspectors visit each farm at intervals of from 4 to 6 weeks to weigh and test the milk from each cow. At the end of lactation certificates of production for each cow are issued, based upon the daily weights of milk taken by the breeder or computed from the weights taken by the inspectors. The certificates issued under this system are recognized as the official records of production for all purposes. There is an annual fee of one dollar for each cow tested.

The Provincial Department of Agriculture supervises the testing of both purebred and grade herds for the individual breeders of the province. There are two plans offered. Under Plan 1 the dairyman agrees to weigh the milk every day and make monthly production reports. Under Plan 2 the dairyman weighs the milk produced by each cow during a 24-hour period once a month for a computed record. The dairyman takes samples of milk from his individual cows once a month for shipment to a testing center where they are tested by an official of the Dairy Branch. Certificates (Blue, Red and Gold seal) are issued for cows meeting certain production requirements under Plan 1; and Green seal certificates for cows under Plan 2. The cost of the Provincial testing service is \$1.00 for every ten cows in the herd.

Cow testing puts dairying on a business basis and demonstrates to the dairymen how the dairying enterprise can be made more profitable.

Dairy Barn and Equipment

Success in dairying cannot be attained without the use of suitable buildings. It is essential that cows be given comfortable and healthy shelter during the winter time, and that facilities be such that milk fit for human consumption can be produced. This does not mean that expensive buildings must be constructed since the essential features can be provided at reasonable cost.

Undue exposure of the cattle to inclement weather during both summer and winter has resulted in heavy losses to dairymen mainly through the lowering of milk production. Dairy cows which receive suitable shelter, feed and care will remain in better health and produce more milk at less cost than cows kept under poor conditions.

There are certain features that are essential in the construction of a suitable dairy barn. It should (1) be well lighted, (2) be well ventilated, (3) have facilities for maintaining sanitation and (4) have ample space for storing feed. There are other features that are desirable, such as (5) suitable arrangements for the economical use for labor, (6) warmth, (7) permanence, (8) reasonable cost, and (9) attractive appearance.

Sunlight is very important.

Good lighting is important for sanitation and health and provides more pleasant conditions for both man and beast. Sunlight kills germs, promotes warmth and ventilation and aids in keeping the barn dry and sanitary. A barn that is dark and damp cannot be kept sanitary. It is not a healthy place for cows to live or man to work. The production of clean milk in such barns is an impossibility. In constructing a barn, most of the windows should be on the sides getting the most sunshine and so placed that all parts are well lighted. At least five square feet of glass area should be provided for every one hundred square feet of floor space.

Fresh air is as necessary as feed.

Lack of fresh air can seriously affect the health and production of dairy cows. Cows exhale air that contains three times the moisture, one hundred times the carbon dioxide and only three quarters of the oxygen of fresh air. The air cows inhale can also be contaminated with barn odors. Unless good ventilation is provided, barn air soon becomes polluted and unfit for cows to breathe. A suitable ventilating system keeps the air in circulation and fresh.

The most satisfactory system for an average size barn is one in which there is one air outlet and numerous inlets. The inlets allow air to enter on the sides near the ceiling and to be removed

from the center near the floor level. The amount of fresh air taken in to the barn can be controlled by a damper in the outlet flue without changing the openings of the inlet flues except in the presence of strong winds. Under average conditions an outlet flue two feet square in size would create proper air circulation for sixteen head of mature stock. This is at the rate of one square foot for four head.

Sanitation aided by proper barn construction.

Sanitation is obtained not only by providing light and fresh air, but by keeping the barn and cows clean. The barn should be arranged to facilitate easy removal of manure. Cement floors and walls without ledges, sharp corners or crevices, help to promote sanitation because there is less chance for filth to collect and disease bacteria to grow. Sloping floors and gutters with a drainage system to carry away all liquids help greatly to keep the barn dry and sanitary.

Feed storage should be ample.

Dairy cows in milk consume more feed than any other class of farm animals. Barn lofts in which large quantities of hay can be stored save considerable labor. When the herd is large there is an advantage in having the loft equipped with grain bins, storage space for commercial supplements and with facilities for the preparing of concentrate mixtures. Hay and grain chutes should be arranged so as to make roughage and grain feeding easy.

A well arranged barn reduces labor.

The arrangement of the barn should be planned to enable labor to be used most efficiently. Any convenience which simplifies feeding and cleaning reduces labor requirements. In barns with two lines of stanchions, cows can face outward or face the center. When facing outward the removal of the manure and milking procedure is made easier, while on the other hand when facing the center, feeding can be done more quickly.

Warmth in a barn is desirable, but not essential.

Cows do best in a cool barn, temperatures of forty to forty-five degrees Fahrenheit being more desirable than higher temperatures. Barns kept at below freezing temperatures have not proven detrimental to cows if provision is made for ample bedding and freedom from cold drafts. The discovery of this fact has led to an increase in the popularity of a new type of barn in which the cows are kept loose in a pen and taken out only at milking time to a milking room of three to five stalls.

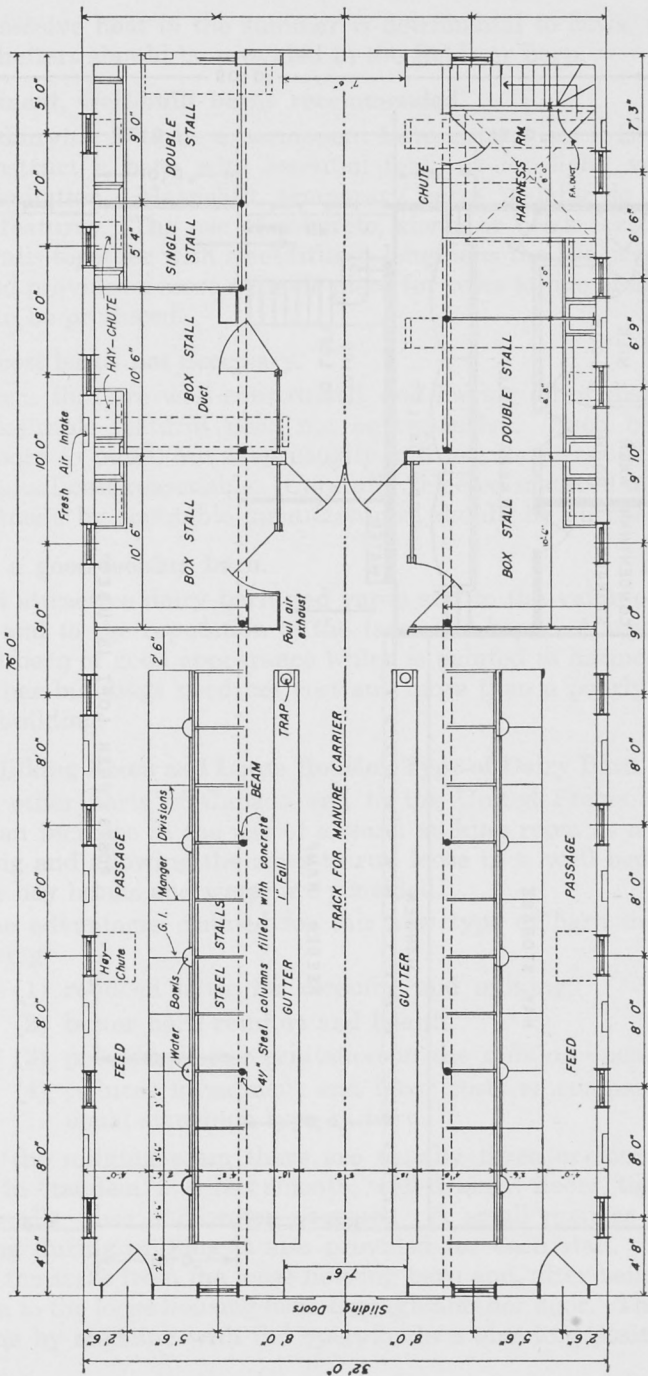


Fig. 13—General Purpose Barn Plan. (Taken from plans prepared by the Provincial Department of Public Works.)

Excessive heat in the summer is detrimental to cows, and suitable shelters should be provided in the fields or barn.

Permanent, well-built barns recommended.

If dairying is to be a permanent farm enterprise, it is desirable to construct a barn with essential features for light, ventilation and sanitation. Makeshift, temporary barns usually do not have these features. The use of concrete, stone, or brick for the floors and walls together with steel fittings lengthens the life of the building and provides a more suitable place for cows to live and for clean milk to be produced.

High cost barns not necessary.

Barns that are well constructed, and having all of the essential and desirable features need not be expensive. Such barns may cost more to build, but they usually will last long enough to make the annual cost reasonable. Carefully selected material and equipment made by reputable manufacturers should be purchased.

Build a good-looking barn.

An attractive dairy barn and yards add to the value of a farmstead and to the reputation of the farm and herd. A well proportioned barn of good appearance which is painted to harmonize with the other buildings need not cost any more than a poorly planned, ugly building.

The Milking Room and Loose Housing Type of Dairy Barn.

In other parts of Canada and in the United States there has been an increase in the use of a small milking room as a place for milking and allowing the cows to run loose in a well bedded barn where hay bunks and water are provided.

The advantages claimed for this new type of barn include the following:

- (1) reduced labor for cleaning and milking;
- (2) better herd comfort and health;
- (3) provides better sanitation in the milking operation;
- (4) reduces investment and labor costs as compared to the usual stanchion type of barn.

In the milking room there are usually three or four elevated stalls in "tandem". It has smooth, well-drained floors, tight, washable walls, hose and water pressure. A small manger for grain feeding during milking is also provided for each stall. The cows enter the stalls from the loose housing barn and, after being milked, return to the loose housing barn through another door. The milking is done by machine with the operator in a standing position. The

room or rooms for the cooling, cleaning and storing of milk and utensils are connected to the milking room.

The loose housing barn can be of simple construction. It contains pens for calves and for cows that are sick or ready to calve. Hay and silage are fed in large bunks. A water trough is also provided. The barn is bedded daily but the soiled bedding is not removed except in the spring or periodically as the weather permits. It is estimated that about twice as much straw is required for bedding as for a stanchion type barn.

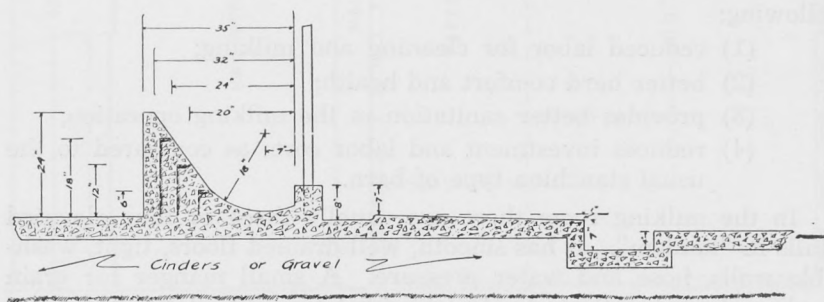
TABLE IV.

General Space Requirements for Stanchion Barn

Cow stalls	Width	Length
Large Cows	3'6" to 3'10"	5'2" to 5'6"
Medium Cows	3'3" to 3' 6"	4'8" to 5'2"
Small Cows	3'0" to 3' 3"	4'4" to 4'8"

Note.—Gutters can be constructed at a slight angle to accommodate animals of various sizes, the longest stalls being located at one end of the gutter and the shortest stalls at the other end.

Cow Box Stalls	9'0"×10'0" to 11'0"×12'0"
Partitions approx. 4'6" high.	
Bull Pens	10'0"×12'0" to 12'0"×14'0"
Partitions approx. 5'4" high.	
Calf Pens'	20 square feet for each calf
Partitions approx. 3'9" high.	
Ceiling height	7'6" to 8'6"
Feed alley, cows facing in	4'6" to 6'6"
Feed alley, cows facing out	4'0" to 5'0"
Litter alley, cows facing out	8'0" to 9'0"
Gutters (sloping to drains)	16" wide, 4" deep
Window space	5 sq. ft. glass to 100 sq. ft. floor space
Ventilator outlet	1 sq. ft. to 4 head mature animals



TYPICAL DAIRY STALL

Fig. 15

Diseases of Dairy Cattle

BY

J. G. O'DONOGHUE, V.S., D.V.M.

Extension Veterinarian, Department of Agriculture, Government of Alberta

The dairy cow is probably the most highly specialized animal of all our domestic stock. Through generations of selective breeding there has been developed an efficient milk-producing machine.

The development of peak efficiency for milk production has also served to render the animal more susceptible to disease. We cannot expect to find the same rugged disease resistance in a dairy cow that we would expect from a range beef cow.

There is the large, pendulous udder, an organ of wondrous efficiency, but easily bruised or injured and highly susceptible to the disease germs that cause mastitis. Forced feeding is practiced in most herds in order to maintain high milk production. Such practices place additional strain on the animal and while not in themselves harmful, lack of care on the part of the herdsman in supplying complete rations, or in following accepted feeding practices, can have disastrous results. Calves must be raised the year round and in the case of winter calves, a good standard of sanitation must be constantly maintained.

The failure to observe the principles of good dairy herd management, and recognized ration schedules is an open invitation to disease problems. In the prevention of disease, herd owners can do more than they realize by merely keeping a healthy, well-nourished herd, properly housed, in clean sanitary surroundings.

Unfortunately, disease will occur in the best of dairy herds. When it does, it is strongly advisable to have the services of a qualified veterinarian if one is available. Good nursing of sick animals is essential. The animal should be made as comfortable as possible and supplied with a light, laxative, nourishing diet. Particularly in the colder seasons of the year, keep the animal warm, blanket it and protect it from draughts.

The aim of all dairy herds is maximum efficiency, and efficiency depends upon a healthy, disease-free herd, which itself rests upon proper housing and adequate balanced rations.

BRUCELLOSIS, Bang's Disease.

Brucellosis, often referred to as Bang's Disease or contagious abortion, is one of our most serious diseases of cattle. Not only

is it the most common cause of abortion in our herds, but is also responsible for retained afterbirth, sterility troubles and decreased milk production. And most important too is the fact that the germs which cause Brucellosis in cattle are responsible for undulant fever in man. It is possible for humans to contract undulant fever from a Brucellosis infected cow, either by drinking the raw milk or at times, by merely being in contact with the infected animals.

Cause.

Brucellosis is caused by a bacterium named *Brucella abortus*. These germs normally live in the genital tract of infected cattle. During pregnancy, the irritation and inflammation they cause in the womb or uterus interferes with the nourishment of the unborn calf, resulting in abortion and retained afterbirth. At calving, the fetal membrane and genital discharges from an infected cow are heavily contaminated with Brucellosis bacteria. If good sanitary practices are not followed these discharges and membranes will serve to spread the infection to clean animals in the herd.

Symptoms.

To best understand the symptoms and course of Brucellosis consider a herd that has been free of infection and has had the disease introduced, usually by a purchased cow. The first sign of the disease will be that one cow will abort at any time between the second and seventh month of pregnancy. For a period of two years or more there follows what is commonly called an "Abortion storm". The infection is spreading to the other animals in the herd and 50% or more of the cows will abort. The abortion rate gradually decreases and usually it is only first and second calf heifers that will lose their calves, or Brucellosis free animals that are brought into the herd.

The explanation of this course of the disease is quite simple. Animals that become infected with Brucellosis will usually abort only once; in rare instances we find cows that abort the second time.

It becomes evident, that because a herd is not troubled with abortions, it is not safe to assume that it is free of Brucellosis. Despite normal pregnancies, there are still the attending evils of sterility problems, retained afterbirths and the danger to humans who are handling the animals or consuming raw milk from them. Bulls may become infected with Brucellosis, but they are not as important a factor in the spread of the disease as was formerly believed.

Diagnosis.

The only accurate means of diagnosis is the blood test. Blood samples are drawn by a veterinarian and these samples are sent to the Veterinary Laboratory. In the laboratory it is possible to determine whether or not the animal is affected with Brucellosis from these blood samples. An owner should always suspect Brucellosis whenever there is a history of abortion in the herd, recurrence of retained afterbirth or breeding difficulties.

Prevention and Control.

An owner can do much to prevent the introduction of Brucellosis into his herd.

1. Be careful in the purchasing of new additions to the herd. Records show that most often the disease has been introduced into clean herds by the addition of an infected cow. Have all new animals blood tested before they are brought into the herd.

2. Practice good sanitation, particularly at calving time. The infected cow is spreading the Brucellosis germs constantly but she represents the greatest threat at calving time. The fetal membranes and genital discharges are heavily contaminated with the bacteria. Isolate cows in a clean parturition stall a few days before calving and keep them there until all genital discharges have ceased after calving. Carefully gather up and burn or safely dispose of the afterbirth and all the contaminated litter and bedding.

3. **Calfhood Vaccination.**—By following a calfhood vaccination program, it is possible to raise Brucellosis-free cows in an infected herd. The protection given to calves by vaccination lasts for 4 to 5 years and if a yearly program of vaccination is faithfully followed, it is possible to economically dispose of the Brucellosis infected animals.

Heifer calves are vaccinated between the ages of 6 and 9 months. This requires a qualified Veterinarian. To encourage vaccination, the Canadian Government supplies the vaccine, and the Government of Alberta has organized vaccination campaigns in the various municipalities. As a result, calves can be vaccinated at nominal cost to the owner.

Brucellosis Restricted Areas.

At the request of livestock owners in a municipality, Brucellosis Restricted Areas may be established requiring the compulsory vaccination of all heifer calves. The eventual aim of such a program is to create Brucellosis-free municipalities. Regulations are enforced requiring vaccination of all heifer calves, branding of infected animals, and control of auction sales. There are a number of such areas in Alberta at the present time.

MASTITIS, Garget.

Mastitis is the greatest problem confronting the milk producer. It is a disease of the udder of cows. The disease attacks the udder destroying the milk secreting tissues, with the resulting decrease in milk production. Eventually, the udder is so badly damaged that the cow is no longer an economical milk producer and must be disposed of long before the end of what would ordinarily be her normal period of usefulness.

Cause.

Mastitis is caused by bacteria or germs which gain entrance to the udder through the teat opening. These germs will spread from one animal to another and any injury to the teats or udder serves to make the entrance of these bacteria easier. Heifer calves may become infected by being sucked by calves fed milk from Mastitis cows. This is the reason why heifers are sometimes found to be infected with Mastitis in their first lactation period.

Symptoms.

There are two types of Mastitis, acute and chronic. The acute type is the least common and is usually the result of injury to the udder. It follows a rapid course, with severe swelling and inflammation of the udder and sometimes results in the death of the cow.

The chronic type, though not so rapid in its course, is the greater problem to the dairy herd. The germs of chronic Mastitis will live and develop in an udder for months and years, gradually destroying the milk secreting glands which are replaced by hard, fibrous or scar tissues. This reduces milk production and the quality of the milk as well as the value of the cow.

Throughout this period the milk may be normal in appearance but on occasion, particularly at freshening or during the drying off period the milk will be abnormal, containing flakes, clots and even blood. It must be remembered that in such an animal, despite the normal appearance of the milk, Mastitis germs are damaging the udder and probably spreading to other animals in the herd.

Diagnosis.

Acute Mastitis is quite evident. There is usually a history of injury, and gross swelling and inflammation of the udder. The chronic type is usually recognized by the appearance of flakes, clots and blood in the milk. Accurate diagnosis of Mastitis in a herd may be made where it is possible to have milk samples taken and submitted to the laboratory. Mastitis germs if present, can be found in the milk samples.

The best aid a farmer has is the strip cup. This is a small cup with a fine wire screen over the top of it. The first few streams of milk are directed through the screen and small clots and flakes, if present, will collect on the screen and are readily noticed. Commercial indicator cards which show a colour change when moistened with Mastitis milk are of some use, but not as reliable as the regular use of the strip cup.

Prevention and Control.

Good sanitation and proper milking procedures are of prime importance in the prevention and control of Mastitis. The sulfa drugs and penicillin are drugs which are effective in curing some types of the disease, but they should be considered as aids in controlling the disease rather than an absolute cure.

1. Prevent udder injuries by having clean, well drained barn yards. Clean the yard of old machinery, barb wire or objects which might cause injury to teats and udders. Provide ample bedding and stalls of proper length in order that udders will not be hanging in the gutter when the animals are lying down.

2. Have milking machines properly regulated and be scrupulously clean in your milking procedure. Remember that Mastitis germs can be carried from an infected cow to a disease free one by dirty teat cups of milking machines or the hands of a milker. Wipe udders with a cloth rinsed in warm disinfectant before milking. Dip the teat cups in disinfectant solution between cows. Do not milk onto the floor.

3. Use a strip cup regularly. It is the means of early diagnosis, and early recognition is imperative if treatment is to be successful.

4. Place known infected cows at the end of the milking line and milk them last. Don't carry the germs from an infected cow to a non-infected one.

5. If possible have milk samples taken and sent to the Provincial Veterinary Laboratory, Alberta Department of Agriculture, Edmonton. This will give a complete herd picture and make control easier and more logical.

If a veterinarian is available he should be called for the treatment of Mastitis. Some animals are hopeless cases to treat and should be eliminated from the herd. The farmer can do most in following the simple procedure of good sanitation and proper milking procedures. The sulfa drugs are very effective in certain cases by preventing general blood poisoning. Penicillin is used in the form of penicillin bougies or ointment. These are merely inserted into the teat canal after milking and are quite effective in curing early cases of the disease. Aureomycin, streptomycin and other

newer drugs are available and are used in the same manner as penicillin.

MILK FEVER.

Milk fever is a disease of high producing dairy cows, usually between the ages of 4 and 9 years, and occurs between 12 and 72 hours after calving.

Cause.

Milk fever is believed to be the result of a lack of calcium in the blood. During pregnancy there is a heavy demand for calcium for the bones, tissues of the developing unborn calf, and with the sudden commencement of milk production further calcium is lost and Milk Fever results.

Symptoms.

The disease occurs shortly after calving and the first symptoms of nervousness and excitability are not usually noticed. The animal soon shows difficulty in standing and finally goes down. When down they appear unconscious and the head is often twisted to one side.

Prevention and Treatment.

A veterinarian should be called immediately in cases of Milk Fever. If the blood calcium can be restored by the injection of a calcium solution the animal is up and quite normal in a few hours.

If a veterinarian is not available the inflation of the udder with air may save the animal. Udder inflation outfits may be purchased but in using them care must be taken to see to it that all equipment is scrupulously clean. This method is not without danger but in some instances may be the only means available.

Proper care and feeding of the pregnant animal helps in the prevention of the disease, particularly the supplying of adequate amounts of calcium.

It is claimed that if an animal is not milked out for a day following calving Milk Fever is often prevented. This is not to be recommended as a regular procedure, but in an animal which seems to suffer from Milk Fever at each calving it may help to prevent its occurrence.

PNEUMONIA.

Pneumonia is an inflammation of the lungs, occurring usually in the colder seasons of the year.

Cause.

There are several bacteria or germs which are the cause of pneumonia in adult cattle. However, pneumonia usually results from exposure to cold, sudden chilling, and damp, draughty stables or barns.

Symptoms.

The symptoms depend to some extent upon the severity of the attack. Mild cases may show only a high fever, loss of appetite and difficult breathing. In more severe cases there is marked depression and prostration. The temperature is high, breathing is very difficult, nostrils are dilated and there may or may not be a nasal discharge. Coughing is sometimes quite noticeable.

Prevention and Treatment.

Respiratory diseases can be prevented by the provision of dry, warm, well ventilated barns, that are free from draughts. Protect the animals from sudden chilling, especially during the winter months.

Obtain the services of a qualified veterinarian. Hygiene and nursing are most important in the treatment of affected animals. Provide warm, dry, comfortable quarters and blanket the animal if the weather is cold. Liniments may be applied to the chest. Supply a light laxative diet and clean fresh drinking water. A mild laxative of half a pint of raw linseed oil daily is often beneficial. Sulfanilimide or sulfamethazine given in recommended doses are probably the drugs of choice.

INDIGESTION.

Cattle frequently suffer from indigestion. The large rumen ceases to function properly, loses its muscular movements and the animal is no longer able to eat and digest its food.

Cause.

There are many contributing causes to indigestion in cattle. Often it is the result of nails or other small foreign objects which the animal has swallowed and which cause irritation and inflammation in the rumen or paunch. Overeating of grains, sudden changes of feed, overfeeding of a dry, heavy roughage diet, or the feeding of spoiled or damaged hay, all will cause indigestion.

Symptoms.

In mild cases there is loss of appetite and scanty bowel passages. The animal is dull, stops chewing its cud and milk production is greatly reduced. In some severe cases poisons are absorbed from

the intestines, the animal is greatly depressed, unable to stand, the extremities are cold and death soon follows.

Treatment.

Simple indigestion usually responds to a laxative of 1 to 2 pints of raw linseed oil. Tartar emetic, given at the rate of a teaspoonful in 2 quarts of warm water every few hours for 16 hours is helpful in more obstinate cases. If animal is bloating give an ounce of creolin or turpentine.

Indigestion in cattle is a very serious condition and it is strongly advised that a veterinarian be called if one is available.

BLOAT.

Bloat is a common digestive disturbance in the cattle but its cause is not fully understood. It is an excessive production and/or accumulation of gas in the rumen. In acute cases animals will die in a very short time if not treated promptly.

Cause.

It occurs most frequently when cattle are turned on to legume pastures. Alfalfa and clovers will cause bloat, particularly when the pasture is wet. Thick immature stands of alfalfa are considered dangerous. Alfalfa pastures, wilted by a dry spell in the summer, have been known to cause bloat.

Unfortunately the actual reason why legume pastures will cause bloat is not known; although most authorities believe it to be associated with the lack of fiber or roughage quality that stimulates belching under normal conditions.

Symptoms.

In acute cases the symptoms are well marked. It appears suddenly and the left flank is greatly distended with gas. Breathing becomes difficult, the nostrils are dilated, mouth open and the tongue protruded. Moaning or grunting occurs often. The pressure of the gas interferes with the function of the lungs and heart. The gases themselves may exert a toxic effect.

Prevention and Treatment.

Many farmers have used alfalfa pastures without having losses from bloat. One thing to remember is that animals should not be turned into lush legume pastures if they are not accustomed to them. Certainly they should not have access to them in a hungry state when there is danger of consuming large quantities rapidly. (See page 47 for further recommendations.)

Medicinal treatment consists of the administration of a half pint of kerosene or coal-oil. Two ounces of turpentine or creolin

are sometimes effective. These medicines should be given in one quart of milk. A gag of a piece of rope or wood placed in the animal's mouth helps in allowing the gas to escape through the mouth. When emergency treatment is required a trochar and canula should be used. The point of insertion is situated equal distances from the point of the hip, the last rib and the vertebrae or backbone on the left flank. A small incision is made in the skin, the trochar and canula forced through the skin and muscle and into the rumen. The trochar is now removed leaving the sheath or canula in place, allowing the gas to escape. Reinsert the trochar before removing the canula.

The animal should have a light laxative diet for several days after it has suffered from bloat.

WINTER DYSENTERY.

This is a disease of adult stabled cattle that occurs during the winter months and is characterized by severe scouring. It usually follows a mild course but fatalities will occur. It is of common occurrence in dairy herds in Alberta.

Symptoms.

The disease appears suddenly. One or two animals begin to scour and within a few days the greater part of the herd is affected. The scouring is the most marked feature. It is profuse, thin and watery and in some cases even bloodstained. Affected animals lose flesh, and become thin and gaunt in a very short time. Milk production is sharply reduced. The disease runs its course in an animal in from ten days to two weeks, at the end of which time the animal will have recovered.

Treatment.

The animals should be encouraged to drink and fed only light diet. A tablespoonful of creolin in water, given daily, is often effective. Some recommend a pint of raw linseed oil and two ounces of turpentine. Sulfa drugs may be used in severe cases.

FOOT ROT.

Foot rot is fairly common in some districts of Alberta. It is caused by germs which attack the tissues of the foot. These germs are found in muddy sloughs, mud holes, and in muddy, poorly drained yards and pens.

Symptoms.

It is first noticed as a lameness. The foot is tender and the animal shows a decided limp. Upon examination swelling is found around the coronet or above the hoof. In time the swelling

abscesses and pus exudes. If left unchecked, the foot and leg become greatly enlarged and the bones and hoofs are permanently damaged.

Treatment.

There is a highly satisfactory cure for foot rot. Its treatment is best administered by a veterinarian since the drugs are dangerous and must be used with care.

Sulfapyridine or sulfamethazine given orally at the rate of one grain per pound of body weight is highly effective.

The foot itself may be bathed in a hot creolin solution or a solution of bluestone.

If foot rot is a herd problem, fence off mud holes and drain muddy yards. Provide a foot bath filled with slaked lime or some suitable disinfectant and place it at the barn door or by the water trough; any place where the cattle are forced to walk through it daily.

STERILITY.

Breeding troubles are all too common in our dairy herds. Often they are the result of disease but quite often, too, the cause is found to be nutritional in origin. Make certain that good balanced rations, supplying the necessary quantities of vitamins and minerals are being fed.

The following points may be of some help in the prevention of breeding difficulties:

1. Eradicate Brucellosis or Bang's disease. This disease is one of the most common causes of sterility in cows.

2. Isolate cows at calving time. Provide clean maternity stalls. If assistance is required in calving be sure that the hands and arms are washed thoroughly in warm soapy water. Wash the external genital organs of the cow. Do not use strong, caustic disinfectants. Keep the cow isolated until all genital discharges have ceased.

3. Retained afterbirth is an indication of disease or inflammation of the uterus or womb. Most often it is the result of Brucellosis. If a veterinarian is not available be careful in its removal manually. Never use force; don't be in too much of a hurry, and loosen only those parts which come away easily. Capsules composed of boracic acid or sulfa drugs inserted into the uterus will sometimes prove beneficial. The uterus is very sensitive and is easily permanently damaged by rough treatment or unclean hands and equipment.

4. Never breed a cow when there are still discharges from the genital tract. It might be the indication of contagious disease and the disease may be spread to other cows by the bull.

5. Allow a cow at least one heat period following calving before breeding her. In normal cows, highest conception rate is usually obtained from services 75 to 100 days after calving.

6. Some breeding difficulties are inherited. Try to select cows from good breeding families.

7. Prompt treatment of sterility is often effective where delayed treatment is disappointing. Call your veterinarian early.

CALF SCOURS—WHITE SCOURS.

This is an acute infectious disease of newborn calves occurring during the first few days of life. It is more prevalent during the fall and winter months in stabled calves. The predominant symptom is a white diarrhea but affected animals are soon prostrate and once established the infection will spread to older calves.

Cause.

Scours are caused by germs which are commonly present in stable manure and litter. These germs gain entrance, either orally or through the open navel of the calf. There is no doubt now but that a deficiency of vitamin A is one of the important contributing factors to the disease. Improper feeding, failure to supply the calf with colostrum, and unsanitary feeding practices are all contributing factors.

Symptoms.

The calf is normal at birth but within a few days develops a thin, watery, white-tinged diarrhea. The disease is severe and the animal becomes weak and depressed. Death soon follows. Once established the infection will spread to older calves.

Prevention and Treatment.

Prevention is the most important factor in the control of calf scours.

1. Provide the pregnant animal with a proper diet. The calf receives from the colostrum great quantities of vitamin A. The condition of a newborn animal rests entirely upon the condition of the mother.

2. Provide a clean maternity stall. It should be warm, dry and free of draughts and should be thoroughly cleansed and disinfected before the cow is put into it.

3. At birth disinfect the navel of the calf with tincture of iodine or some other suitable disinfectant.

4. The calf must receive the colostrum milk. This is most important. It supplies the necessary amount of vitamin A as well

as antibodies or disease-preventing factors. Then follow a recognized feeding schedule for the raising of young calves.

5. Be scrupulously clean with all feeding utensils used in feeding the calf. If the animal shows an inclination to eat straw or litter it is best to muzzle it. Some recommend the use of a muzzle as a routine procedure to prevent the ingestion of foreign material.

Treatment is not very satisfactory. Once the disease occurs great care must be taken to prevent its spread to other calves in the barn. Large doses of vitamin A in the form of feeding oils are important. A laxative of 2 to 4 ounces of castor oil followed by bismuth subnitrate in doses of one-half ounce twice a day may prove helpful. Of the sulfa drugs, sulfamethazine or sulfamerazine given according to the direction supplied with the drug are probably best.

On premises where the disease re-occurs a mixed anti-calf scours bacterin may be of some value.

CALF PNEUMONIA.

Pneumonia is a serious disease of dairy calves, most often affecting animals under six months of age. It is most prevalent during the winter months in improperly ventilated barns.

Cause.

Calf pneumonia is the result of infection and once established can spread to all the calves in a herd. As with all respiratory diseases, one finds it occurring most frequently in animals kept in damp, draughty, poorly ventilated stables and barns.

Symptoms.

The first symptoms are dullness, loss of appetite and fever. The breathing soon becomes labored and rapid and coughing is marked. In most cases there is a thick discharge from the nostrils. The disease runs a protracted course with animals dying after several days of severe illness. Abscess formation in the lungs is a common sequel and animals are sometimes permanently affected.

Prevention and Treatment.

Hygiene is most important. Segregate the sick animals to prevent the spread of the disease and provide quarters that are warm, dry and free of draughts.

If possible obtain the services of a veterinarian. Sulfanilimide or sulfamethazine are the best drugs to use in treatment.

A mixed calf pneumonia bacterin may be used as a preventative measure on premises where the disease re-occurs.

RINGWORM.

This is a skin disease which affects the calves and younger animals. It is caused by a fungus which burrows into the skin, destroying the hair roots, with the resulting loss of hair on the lesion. It will spread from animal to animal and to humans.

Symptoms.

As the fungus grows in the skin it causes the loss of hair in characteristic round circular lesions, forms a thick black crusty scab. These lesions are found chiefly in the region of the head and neck, although they are sometimes present in other areas. Calves and younger animals are most frequently attacked but adult cattle are also susceptible.

Treatment.

Remove the scabs by scrubbing with a stiff brush and warm soapy water. The application of iodine in any form is effective treatment. Tincture of iodine may be applied with a small brush or iodine ointment used.

Segregate affected animals to prevent the spread to other animals and exercise care in handling the animals as the disease can be spread to humans.

TUBERCULOSIS.

Fortunately the percentage of Alberta cattle infected with tuberculosis is quite small. Tuberculosis is caused by a germ called the tubercle bacillus. An animal may be suffering from tuberculosis and yet show no visible symptoms of the disease. Such an animal can readily spread the disease to non-infected animals and represents a threat to humans consuming milk from it or eating the meat from it after it has been slaughtered. Tuberculosis can not be tolerated in any of the domestic livestock.

The tuberculin test is used to diagnose tuberculosis in cattle. The test requires a veterinarian and there are several methods by which it may be applied. The one most commonly used is the intradermal test. A few drops of tuberculin are injected into the fold of skin at the base of the tail and if the animal is affected with tuberculosis a reaction or swelling can be observed in from 72 to 96 hours after the injection.

Tuberculosis control is under the supervisor of the Dominion Government. There are several plans or policies for tuberculosis eradication.

Accredited Herd Plan.

The object of this plan is the eradication of tuberculosis in purebred herds. These herds are tuberculin tested free of charge by Dominion Veterinarian Inspectors. All animals which react to the tuberculin test are branded on the cheek with a large "T" and must be sold for slaughter under federal supervision.

To be eligible for acceptance under this plan a herd must contain at least ten purebred cattle of one breed registered in the applicant's name. The number of purebreds must, however, comprise at least one-third of the total number of cattle in the herd.

As soon as the herd has passed two annual or three semi-annual tests, without a reactor, and contains at least ten registered purebreds, it is designated as a "Tuberculosis-free Accredited Herd."

Compensation paid for reactors is based on two-thirds of the valuation placed upon the animals by Veterinary Inspectors of the Health of Animals Division. The maximum compensation paid under the Act is \$60.00 for purebreds and \$40.00 for grades. Should the meat of the animal be unfit for human consumption, the Dominion Government will also pay, in addition, compensation equal to the market value of the carcass. Compensation on a purebred basis is not paid for reacting animals over six months of age, not registered at the commencement of the tuberculin test. Animals affected with lump-jaw and grade bulls are not eligible for compensation.

Restricted Area Plan.

The object of this plan is the eradication of tuberculosis in definite areas. At least two-thirds of the cattle owners in any definite area must sign a petition for the establishment of such an area under this plan. The petition must be forwarded by the Provincial Minister of Agriculture to the Minister of the Dominion Department of Agriculture requesting that the necessary action be taken. The payment of compensation is based on the same limitations and maximum valuations provided under the Accredited Herd Plan.

Private Test.

In districts where a Dominion Plan is not available a farmer may have his herd tested by his local veterinarian. On a private test the owner signs an agreement to the effect that all reactors to the test shall be permanently marked with a large "T" brand. There is no compulsory slaughter of animals and no compensation payments.

Gestation Table for Cows

Month

Breeding Dates	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Day	Calving Dates											
1	Oct. 10	Nov. 10	Dec. 8	Jan. 8	Feb. 7	Mar. 10	Apr. 9	May 10	June 10	July 10	Aug. 10	Sept. 9
2	11	11	11	9	8	11	11	11	11	11	11	10
3	12	12	10	10	9	12	12	12	12	12	12	11
4	13	13	11	11	10	13	13	13	13	13	13	12
5	14	14	12	12	11	14	14	14	14	14	14	13
6	15	15	13	13	12	15	15	15	15	15	15	14
7	16	16	14	14	13	16	16	16	16	16	16	15
8	17	17	15	15	14	17	17	17	17	17	17	16
9	18	18	16	16	15	18	18	18	18	18	18	17
10	19	19	17	17	16	19	19	19	19	19	19	18
11	20	20	18	18	17	20	20	20	20	20	20	19
12	21	21	19	19	18	21	21	21	21	21	21	20
13	22	22	20	20	19	22	22	22	22	22	22	21
14	23	23	21	21	20	23	23	23	23	23	23	22
15	24	24	22	22	21	24	24	24	24	24	24	23
16	25	25	23	23	22	25	25	25	25	25	25	24
17	26	26	24	24	23	26	26	26	26	26	26	25
18	27	27	25	25	24	27	27	27	27	27	27	26
19	28	28	26	26	25	28	28	28	28	28	28	27
20	29	29	27	27	26	29	29	29	29	29	29	28
21	30	30	28	28	27	30	30	30	30	30	30	29
22	31	Dec. 1	29	29	28	31	31	31	31	31	31	30
23	1	2	30	30	29	1	1	1	1	2	2	1
24	2	3	31	31	30	2	2	2	2	3	3	2
25	3	4	1	1	3	3	3	3	3	4	4	3
26	4	5	2	2	4	4	4	4	4	5	5	4
27	5	6	3	3	5	5	5	5	5	6	6	5
28	6	7	4	4	6	6	6	6	6	7	7	6
29	7	8	5	5	7	7	7	7	7	8	8	7
30	8	9	6	6	8	8	8	8	8	9	9	8
31	9	.....	7	.....	9	.....	9	9	.....	9	.....	9

